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DEPARTMENT OF PUBLIC HEALTH,

NEW SOUTH WALES.

REPORT

ON THE

OUTBREAK OF PLAGUE AT SYDNEY, 1900,

BY

The Chief Medical Officer of the Government and President
of the Board of Health.

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1900.

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LEGISLATIVE ASSEMBLY.

NEW SOUTH WALES.

DISEASES
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OUTBREAK OF PLAGUE AT SYDNEY, 1900.

(REPORT OF THE CHIEF MEDICAL OFFICER ON.)

Ordered by the Legislative Assembly to be printed, 4 *December*, 1900.

The Chief Medical Officer of the Government and President of the Board of Health to the Hon. The Premier and Colonial Treasurer.

Department of Public Health,
13 November, 1900.

Sir,

The recent epidemic consisted in the attack with plague of 303 persons between January 19th and August 9th, of whom 103 died; in addition to the suffering and the indirect losses which these figures denote, it necessitated a very considerable immediate expenditure and caused much damage to the commerce of this port. The object of the following account is to inquire into its origin and mode of spread, with a view to deducing the measures which are likely to be effectual in preventing a recurrence.

It will be seen at last that steady attention to the more commonplace details of municipal sanitation during absence of the disease alone affords a reasonable prospect of future safety. Simple as this conclusion appears it has the certainty which is attainable only through close consideration of the facts which, however, cannot be successfully observed save in the light of precedent investigations made in many branches of science. Thus it is unlikely that it will be easily accepted; yet not merely because the weight of the reasoning which leads up to it is hard to appreciate, but also because men still despise the humble stream, and vainly imagine the rivers of Damascus. There is no royal road to the prevention of plague.

It is hardly necessary to point out that the data described below were not accumulated without forethought and industry; this opportunity is therefore taken of commending to your favourable notice the zealous services rendered by the permanent and temporary members of the Staff, whose special duties are mentioned with their names. The Principal Assistant Medical Officer of the Government (Dr. Frank Tidswell, M.B., Syd., D.P.H., Camb.) remained in charge of the laboratories; his account of the observations and researches made by him will be found in Appendix A. The Medical Officer of Health for the Metropolitan Combined Districts (Dr. W. G. Armstrong, M.B., Syd., D.P.H., Camb.) took charge of the Visiting Medical Staff, which consisted of Dr. Theodore Barker, M.B., Ch.M., Edin., and Dr. Arthur Grieves, M.R.C.S., L.R.C.P., and of the Disinfecting and Ambulance Corps. The Maritime Quarantine Hospital was placed in charge of Dr. W. F. M. Shells, M.R.C.S., L.R.C.P., from February 24th to March 17th, and from the latter date to the end in that of Dr. A. E. Salter, M.B., Ch.M., Melb. Dr. Salter's analysis of the clinical records constitutes Appendix B. Mr. C. P. B. Clubbe, M.R.C.S., acted as Consulting Medical Officer, and visited the Hospital on alternate days; Dr. Gordon Macleod, M.B., Ch.M., Edin., Ophthalmic Surgeon (see Appendix C), was consulted on occasion. The ground external to the hospital enclosure was, on April 13th, placed in charge of Dr. Henry Harvey. The general management of the Quarantine Station was, as usual, in charge of the Superintendent of Quarantine (Mr. James Vincent), assisted by the permanent Quarantine Staff and a considerable temporary staff. The Nursing Staff was supplied from the Coast Hospital and from private sources, the whole being under superintendence of Head-nurse Ford, of the Coast Hospital; the Ambulance Staff was also detached from the same Institution. The Inoculation Branch was controlled at first by the Headquarters Staff, but subsequently by Dr. W. F. M. Shells; from time to time many other medical men shared in this work, in which they were assisted by medical students at the University, and occasionally by the laboratory assistants under Mr. Robert Grant. The *post mortem* examinations were made by the Government Pathologist (Dr. George Henry Taylor, L.R.C.P. & S., Edin.), and by the Pathologist to Sydney Hospital (Dr. Sydney Jamieson, M.B., Ch.M., Edin.), whose notes will be found in Appendix D. Sanitary inspections of municipalities and of buildings on infected areas were carried out by a temporarily engaged staff of instructed inspectors under direction of the Board's Sanitary Inspector (Mr. P. E. Getting). About March 25th this staff was increased to 28 and, under the same officer, was turned over to the Department of Public Works to share in the general scavenging operations about that time commenced. The rat-killing staff afloat was managed by the Collector of Customs (Mr. N. Lockyer), and was under supervision of a Superintendent of Fumigation (Captain G. Tait). Others also ultimately bore their share in the multifarious branches of work entailed by the epidemic, but the present object is to draw special attention to those who were immediately connected with the Department; this statement may, therefore, be concluded by mentioning the name of the Secretary (Mr. C. A. Simms), on whom devolved, among many other things, the arduous and responsible task of keeping up communications and daily records, and of attending to visitors, more especially during the hours from 4·30 p.m. to midnight for many weeks together. All of the officers mentioned worked with an intelligence, discretion, and disregard for their own convenience, which are deserving of high commendation and special acknowledgment. For my own part, I beg leave to express here my sense of the obligation under which their generous coöperation and invariable loyalty, in circumstances which were always trying and sometimes difficult, have laid me.

To the Consul-General for France (M. Georges Biard-d'Aunet) and to the Director of the Pasteur Institute at Sydney (Dr. Emile Rougier) warm thanks are owing for the friendly efforts made by these gentlemen to facilitate despatch from the Pasteur Institute of supplies of the anti-plague serum of MM. Yersin and Roux; as well as to the Consul for France (M. L. Vossion), who at a later date presented the Department with a further and welcome quantity brought from Noumea. Unfortunately, neither arrived until the epidemic had begun to show the signs which betoken the period of decline; nevertheless, the public were reassured at hearing that a specific method of treating the disease had become available.

It will be noticed, doubtless, that the advice given by the Department before the plague came (December 26th), while the epidemic was but threatening (January 24th), and at its commencement (February 24th, see Appendix H), practically coincides with the conclusions drawn from the facts of our recent experience. Had it been generally accepted, it would have been well; but it was then impossible to mention reasons fully, nor could many things for which the public themselves clamoured at much later dates have been done at that time. Now, however, reasons can be deduced from facts within our own knowledge. An effort has been made below to express them in the simplest terms (Sections V, VI, and VII), and so that they may be understood by educated readers with little trouble; but if in spite of this attempt they still wear a technical aspect, it must be remembered that after all Preventive Medicine is a branch of science.

I. THE NATURE OF THE DISEASE.

The number of cases which occurred between January 19th and August 9th was 303. The number available for the following clinical description, however, was 262; for in 39 cases death occurred either before notification, or else so soon afterwards that no clinical observation of importance could be made, while two others lay ill at a distance from Sydney and have been omitted from mention.

In very few cases the occurrence of declared symptoms was preceded by feelings of malaise and weariness, which lasted one or two days. This ill-marked and uncommon prodromal stage need not be further referred to, and the observed course of illness may be generally described under the following five heads:—

Onset.—This was a period of from one to about twelve hours, during which the patient passed, very often with alarming suddenness, from a state of apparent health to one of severe illness. It was usually ushered in by a rigor which varied in degree from a feeling of chilliness to a severe shivering fit, and which occasionally lasted for several hours. Acute headache accompanied, or immediately followed, the rigor; it was almost invariably referred to the frontal region, was sometimes felt at the vertex, and was never occipital; it was sometimes accompanied with vertigo. Pain in the back and lower abdomen was common. Vomiting almost constantly occurred; like the headache, it sometimes accompanied the rigor, sometimes followed it after an interval of a few hours, occasionally it was represented by a mere feeling of nausea, sometimes it was severe and long-continued; the contents of the stomach were first rejected, afterwards a greenish or bluish bile was thrown up. The face was usually flushed, and the eyes suffused; the pulse moderately quickened, of good volume, and of apparently increased tension. In all cases which fell under observation during this period there was fever, the temperature ranging between 100° and 102° F. The bowels were constipated, most commonly; diarrhœa occasionally occurred, and even at this early stage warranted a bad prognosis; it was generally accompanied with tympanites. Occasionally at this time, also, superficial lymphatic glands in one or other region—the femoral, inguinal, axillary, subpectoral, cervical, etc.—became spontaneously painful; the pain was described as aching or pricking, and was accompanied with slight swelling and a little tenderness. In five cases out of the whole number, unaccountable swelling and pain in a lymphatic gland were the first signs of illness.

Ingravesence.—This period included a part of the first and the whole of the second day of illness: speaking generally, the symptoms to be shown in individual cases became manifest, and gradually increased in intensity. Often, but by no means always, the patient was now unable to rise from bed. The face was most commonly flushed; the eyes, suffused and congested, were either closed or half-open; not very infrequently the complexion was pallid or livid, and the expression pinched; in a few severe cases it was sallow or yellowish, and a peculiar smell exhaled from the patient. The tongue, very frequently, carried a white coating; this was confined to the dorsum, the tip and edges being either bright red or clean, and it continued moist or, in the severer cases, began to dry. The skin was hot and dry; but when the circulation was extremely feeble, as it was in severe cases almost from the onset, it was bathed in a cold perspiration. The temperature ranged at this time from 101° to 105° F., and occasionally the highest temperature reached during the illness was attained about the end of the second day. The pulse was now much quickened; it continued full, but began to loose tension; in a few cases it had already become weak, very easily compressible, and even dicrotic. Except in very slight cases, appetite was entirely wanting; thirst continued. The bowels remained constipated as a rule. The patient's general expression could rarely be described as anxious, and most often was dazed: sometimes there was mental restlessness, however, and he would exercise his ingenuity to furnish commonplace explanations of his illness, or of the glandular swelling. At this stage affections of speech, and (when the patient was out of bed) of gait, were observed. That of speech varied between slight blurring and almost complete loss of power to pronounce words, while that of gait was manifested merely by staggering; both were clearly due to muscular incoördination, and consequently a stage of alcoholic intoxication was often simulated. Hebetude describes the mental state of the milder cases at this date;

but in many of the severer kind this had passed into stupor, or even coma, before conclusion of the period. In others, and more commonly, delirium commenced: it was characterised by excitement which not infrequently was furious; the patient constantly struggled to leave his bed, and had to be restrained; he suffered from delusions. In all cases sleeplessness was a marked symptom. The superficial lymphatic gland which had first become painful rather rapidly increased in size, on the average equalling a hazelnut: it was distinct, elastic, and very tender.

State.—The illness having attained the degree of severity above indicated during the first forty-eight hours, became established. The period of maximum intensity was reached; it lasted over the third, fourth, and fifth days, and was sometimes prolonged into the sixth. The temperature now fell, usually ranging between 99° and 102°. The more moderate attacks being excepted, the patient exhibited a state of complete and intense prostration: decubitus was dorsal, the body slipped down in the bed; all excitement abated, and muttering delirium took its place; stupor and coma were likely to supervene. Sometimes diarrhœa set in, and if at all severe was a fatal sign; or external hæmorrhages of grave significance—hæmatemesis, melæna, hæmaturia, or purpura, occurred. The pulse became smaller, weaker, and more rapid, dicrotous, irregular, or running. The tongue continued coated as at first, but now became dry and brown. Albumen was often present in the urine, but always transiently and in small quantity. The bubo increased rapidly in size; the gland often equalled a walnut, while periadenitic effusion increased the swelling to large proportions, and spread over the adjacent glands which were usually very slightly enlarged; although the spontaneous pain which had at first been present in it was almost absent, it continued extremely sensitive; the patient, if not insensible, disposed his limbs so as to avoid pressure upon it, and often its situation could be inferred from the attitude in which he lay. The skin over it also became much reddened. More than half the total deaths occurred on the third, fourth, fifth, or sixth days; they were often due to failure of the heart.

TABLE, I.—Showing the day of illness on which death occurred in 103 fatal cases.

On Day of Illness.	No. of Deaths.	On Day of Illness.	No. of Deaths.	On Day of Illness.	No. of Deaths.
1st	4	8th	6	31st	1
2nd	5	9th	9	38th	1
3rd	12	11th	1	58th	1
4th	20	12th	2	98th	1
5th	11	13th	2	Unknown ...	1
6th	12	17th	2		
7th	11	30th	1		103

During this stage, cough, due to slight bronchitis, and attended by frothy expectoration, was liable to set in. In a moderate proportion of cases scattered patches of pneumonia were observed; the sputa became less aërated, and contained a little blood, which often stained them uniformly and rather brightly; this expectoration did not at all resemble that of ordinary pneumonia.

Decline.—During the sixth, seventh, or eighth days the disease began to decline in the majority of those cases which terminated favourably. The temperature fell as a rule suddenly, and to about normal; but sometimes it was gradually reduced. All the other symptoms showed a rapid amelioration, and immediately on the fall of temperature sleep returned. The face lost its congested appearance, the tongue began to clean, delirium became mild, intermittent, or was present only for a time after awaking. The bubo continued, and during this stage generally began to soften, if it were going to suppurate; but in a good many cases buboes remained stationary for from six to eight weeks, and yet suppurated at last. The pulse continued small, feeble, and easily compressible, and feelings of great weakness began to be experienced.

Convalescence.—About the ninth or tenth day the stage of convalescence was entered upon in the majority of cases. Almost all the symptoms hitherto mentioned entirely disappeared; only great cardiac weakness and the bubo remained. The temperature often became subnormal, usually about the ninth day; it sometimes fell below 97° F., and continued subnormal for from one to three days. Suppuration now proceeded rapidly in the bubo, and was usually accompanied by some slight rise of the evening temperature; the abscess was most commonly opened on the thirteenth day. In a less, but considerable proportion of favourable cases, the inflamed gland began to diminish in size, and gradually disappeared by resorption, but this process occupied several, or even many, weeks. The length of the period of convalescence was very irregular; usually it was established thoroughly by the third week, when debility and some discharge from the bubo alone remained. The wound, however, was rarely severe enough to prevent the patient from taking as much exercise as in other respects he was fit for, though occasionally extensive undermining of the skin long delayed his discharge.

If from the foregoing description of the average course of illness in uncomplicated cases, which terminated either in recovery or death, we turn to consideration of individual cases, it appears that the disease exhibited itself in every degree of severity—that is to say, from a slight attack of fever which necessitated confinement to bed for two or three days at most, accompanied by such swelling of a single gland as was a cause rather of discomfort than of pain, to an ill-defined attack of malaise on which death supervened after a few hours—or more often to an apparently moderate illness, which ended with unexpected death in about forty-eight hours from attack. Of the first degree, Case 1 (Appendix L, p. 77) was a good example, while the following are among those which represent the second and third. Case 240, m., *æt.* 45.—It was noticed that the patient's appetite fell off a day or two before attack, but this was not unusual with him, and he made no complaint; he attended to his clerical duties as usual during the morning of May 19th, but at midday was obliged to leave by a fit of colic; he died at 10 p.m. Case 255, m., *æt.* 55.—The patient rose at 6 a.m. and performed his duties as ostler in the usual way, and without having been heard to complain, until 8 a.m.; made a good breakfast, washed and dressed, and sat by the kitchen fire; at 9·30 a.m. he was found dead. Both of these men were intemperate; but this was not so with Case 242, m., *æt.* 17.—The patient rose at 8 o'clock, and complained of slight headache and nausea; he went out, and at 10 a.m. was spoken with by a policeman who afterwards reported that he made no complaint, and did not appear to be ill; at 2·45 p.m. his breathing became laboured, and at 9·45 p.m. he died. The two following patients died unexpectedly, though not so abruptly. Case 142, m., *æt.* 5.—During April 22nd became feverish and vomited several times; during the next thirty-six hours continued feverish, was sleepy or dull, and a tender swelling appeared in the right groin. He died quietly, but suddenly, at about the fifty-first hour of illness, without manifesting any other symptom. Case 84, m., *æt.* 3.—Woke at 3 a.m. on April 5th, feverish, thirsty, and with some slight muscular twitching. Vomiting set in, and continued till midday of April 6th. During the afternoon seemed much better, and played almost as usual. At 6 a.m. on April 7th muscular twitching again appeared; he was sleepy or indifferent, and feverish, and he died suddenly about the fifty-first hour of illness.

Post-mortem Appearances.—These were observed in twenty-four cases (Appendix D, p. 64), among which the five last referred to above were included. From this set of notes it appears that petechiæ of the skin were noted in ten cases; petechiæ of serous membranes, visceral and parietal, or of the mucous coat of the stomach and intestines, in nineteen. They were usually of the size of a pin's head or a little larger, but sometimes as large as a threepenny-piece; and hæmorrhages, or hæmoglobin staining, in the areolar tissue around internal organs were sometimes noticed, apart from enlarged lymphatic ganglions. The spleen was usually enlarged, rounded, softened, and dark in colour on section; it was noticed that the trabeculæ were obscured in six cases; and in only two was this organ reported to be firm and in other respects of normal appearance. Inflamed, swollen, and sometimes necrotic lymphatic glands were noted in twenty-one cases, while in three none were found. They were surrounded with extravasated blood in fourteen cases, and in a less number of the latter there was also œdema of the surrounding areolar tissues. Buboes (sixteen) were—femoral, eight; inguinal, four; axillary, one; and cervical, three. The heart, which often contained soft, pale-yellow gelatinous clots, showed paleness and softening of the myocardium in four cases. The liver was enlarged in fourteen cases, and was fatty as well in thirteen; this appeared to be a recent change. In two, minute whitish points distributed throughout its substance betokened necrosis; in three cases it was cirrhosed from old standing disease. The cortex of the kidneys was swollen and pale in twelve cases, and occasionally was speckled with pin-point hæmorrhages. In Case 84 the former condition was ascertained to be due to catarrhal nephritis at an early stage. The lungs were the seat of old-standing disease in three instances, in five others they were congested, in three others engorged with blood, and in eight others there was a moderate œdema; in one case lobular pneumonia was noted.

Bacteriological Evidence.—Once the presence of plague in epidemic form has been recognised, a large majority of cases can be quite certainly diagnosed by clinical methods alone; and this is fortunate, because rigid bacteriological proof of the nature of this disease can seldom be had before the fifth day from beginning to seek it. Nevertheless, not merely at the beginning, but during the course of every epidemic, bacteriological proof is occasionally demanded. At the beginning it is essential, in view of the consequences which at present follow on the announcement that an indigenous case of plague has arisen among the inhabitants of a large city or an important seaport. So momentous an opinion should not be given but on absolute proof that the disease is plague, and the proof remains incomplete until it has been supported by a bacteriological demonstration. In the course of an epidemic it is also occasionally required in cases of doubt; for accuracy of diagnosis is a first condition of successful management. But in this case the same rigid proof is not necessary as in the former, and a microscopical examination of the juice of an enlarged gland, or (in few and fatal cases) of the blood, will furnish all the corroboration needed to establish a diagnosis already highly probable on clinical grounds.

Bacteriological demonstration of the nature of the disease already described, consisted briefly in detection in the juice of buboes, and in some other tissues, secretions, or excretions of the diseased body, of a micro-organism which had the following morphological, cultural, and pathological characteristics, and a definite reaction to certain stains. The organism was usually present in enormous numbers in smears made from enlarged glands, or from viscera. The individual elements were segregated, though not infrequently two were seen end to end, as though they had been produced by recent fission: they stained with aqueous solutions of fuchsin, methyl blue, and gentian violet, and did not retain the stain when treated by Gram's method. In stained preparations it presented a matured form, which was either that of a typical bacillus, or else it was whetstone or boat shaped; interspersed among these were rounded, oval, or dumb-bell shapes resembling micrococci or diplococci. The greatest mixture of forms was observed in smears from tissues, but there was always a preponderance of the "mature" forms. The bacillary form had an average measurement of 1·8μ, and a breadth of ·8μ; the latter showed little variation, the extreme measurements of length were 1·6μ and 2·4μ. The rounded forms had a diameter between ·5μ and 1·0μ. The poles of the bacillary form were often more deeply stained than the centre; in some preparations, practically every bacillus showed more or less deeply stained ends, and a central portion which remained clear and unstained, and which varied in width between a small space and the greater part of the body of the bacillus between the ends. In other preparations only a few elements showed this bi-polar staining, and occasionally it was not at all evident. Cultivation on dry or salted agar produced crops of "involution forms"; some elements became greatly enlarged, so as to measure 5 μ. or 6 μ. in length by 1 μ. in breadth, without losing the shape or staining properties just described; others became otherwise altered, and formed sausage, pear, spindle, circular, or oval shaped bodies, having no resemblance to the bacilli from which they were derived. On nutrient agar, inoculated from buboes or viscera and incubated at 37° C., the first noticeable growth appeared in the form of minute bright specks in from thirty-six to forty-eight hours. In a day or two these colonies become colourless hemispheres from ·5 to 1·0 mm. in diameter; some of them then enlarged slowly to a diameter of 2 to 3 mm., became flattened, and cloudy towards the centre. The maximum development was reached in two weeks. Individual colonies were hard to pick up, slipping about under the needle; fused colonies were often tenacious, and could be pulled out in strings. In sub-culture the growth appeared earlier than in the original, and developed as a confluent streak, raised and cloudy along the middle, but with thin, colourless, iridescent borders, which were often corrugated. At room temperature on this medium the growth was seldom distinct in less than five or six days, and only reached its maximum development in about three weeks. In beef-broth the growth was usually visible on the second day of incubation, in the form of crumblike spicules attached to the sides, with more or less deposit at the bottom of the tube, the broth itself remaining clear and transparent; but in other cases a moderate uniform turbidity was produced. Growth in broth-flasks containing oil resulted in production of a film, scanty crops of stalactites, and a copious deposit. The stalactites present at any one time never exceeded six or eight, and became detached, and sank to the bottom on the least jar; that more were not found at one time was probably due to unsteadiness of the laboratory shelves. The growth in milk was less abundant than in broth, and the milk remained unchanged. Inoculation of guinea-pigs was usually followed by death in four or five days; the extremes were two to ten days, but six were rarely exceeded. The inoculations were made into the inner side of the knee. *Post-mortem* there was sometimes hæmorrhagic swelling at the site of inoculation, and this extended up the thigh; there was always swelling, and usually periadenitic effusion and hæmorrhage of the corresponding femoral glands, while sometimes the related inguinal, and less often the lumbar, glands showed similar changes. There were petechial hæmorrhages under the skin, the serous membranes, and in the viscera. The lungs were almost always more or less inflamed, the liver enlarged (sometimes to twice its normal size), and the latter usually exhibited a fine mottling caused by appearance of white points or by small hæmorrhages. The spleen was enlarged to two or three times the normal, marked with white spots on its surface, was dark in colour, and had thick or rounded edges. The kidneys were enlarged, pale, and, as a rule, full of small hæmorrhages; the suprarenals were usually congested, and of a deep red colour. Occasionally plague bacilli were limited to the seat of inoculation and the bubo; but usually they were present in all parts of the body, though they were not always recoverable from heart's blood. They were twice recovered from the urine, and were never found in the bile. A bacillus having precisely the same characteristics and the same pathogenicity was recovered from the organs by culture. For a full account of the bacteriological observations made during this epidemic, Appendix A, p. 50, from which the foregoing abstract has been made, should be consulted.

From the foregoing account of the usual course of illness, which has been compiled exclusively from the symptoms recorded of each of the 262 cases which could be clinically observed, from the brief abstract of the *post-mortem* appearances noted in the twenty-four cases which alone were examined in that way, and from the abstract account of the bacteriology of the disease given above, it will be seen clearly that the epidemic illness now under consideration was plague. On comparing it with the published accounts of plague as it appeared in other parts of the world, it will be seen that it might have been compiled from records made in China, in Portugal, in India, in Mongolia, in Mauritius, or, in short, from the records of plague outbreaks in any part of the world from which such records are forthcoming. Nevertheless, certain minor differences between the disease as seen here and as it has been seen in India and China, for instance, are distinguishable. But they are non-essential; they are differences in degree of severity or of fatality, and are doubtless due to the indirect influence of local conditions of life—of feeding, housing, cleanliness, and also of race. And of the three recognised forms under which plague exhibits itself—that is to say, the bubonic, the septicæmic, and the pneumonic, the bubonic form was almost exclusively encountered. The septicæmic form was observed only in 17 cases, of which 15 were fatal; primary plague pneumonia probably not once, although a single case was met with (in a Chinese) which possibly may have been an instance of it, the circumstances having prevented the fact from being ascertained. Bronchitis and secondary pneumonia were not uncommon, carbuncles were seen in two instances, and inflammatory and suppurative affections of the eye six times (Appendix C), but for an analysis of the whole series of cases reference must be made to Appendix B, p. 58.

II.—PROGRESS OF THE EPIDEMIC.

Sydney alone was infected, although several persons first fell ill after leaving for distant places—a matter which will be further mentioned (see p. 32). The total population of the metropolitan area, as defined for registration purposes, was estimated at 438,300 on December 31st, 1899; that of the metropolitan districts as combined for purposes of sanitary administration, was about 456,000. Cases were removed from all parts of the latter area. This population included the small sprinkling of coloured persons usually found at seaports, and a colony of Chinese which numbered less than 4,000 altogether; the latter, for the most part, lived in three separate neighbourhoods. Among the Chinese 10 cases occurred, and 293 among the whites; 226 of the whole number were notified by 87 legally qualified medical practitioners, the remainder (77) having in almost every case been first visited by a Staff Medical Officer.

TABLE II.—Showing the number of attacks and deaths recorded during each week.

Week Ending.	Cases.	Deaths.
20 January	1	0
27 January	0	0
3 February	0	0
10 February	0	0
17 February	0	0
1st.—24 February	2	1
2nd.— 3 March	2	1
3rd.—10 March	5	3
4th.—17 March	12	3
5th.—24 March	10	3
6th.—31 March	23	6
7th.— 7 April	29	9
8th.—14 April	29	12
9th.—21 April	16	8
10th.—28 April	26	7
11th.— 5 May	38	10
12th.—12 May	23	10
13th.—19 May	24	10
14th.—26 May	7	6
15th.— 2 June	17	3
16th.— 9 June	4	3
17th.—16 June	10	3
18th.—23 June	6	0
19th.—30 June	12	3
20th.— 7 July	1	0
21st.—14 July	3	0
22nd.—21 July	2	0
23rd.—28 July	0	1
24th.— 4 August	0	0
25th.—11 August	1	0
26th.—18 August	0	1

The weekly notifications showed stages of increase, state, and decline in the epidemic. During the first three weeks only 9 cases occurred, and they were pretty evenly spaced out. During the fourth and fifth weeks, 22 were notified. In the sixth the epidemic became established, and so continued for seven weeks more; two-thirds (208) of the total cases happened during these eight weeks. The period of decline set in with the fourteenth and continued through the nineteenth week; it was marked by great irregularity in the number of cases notified, the series having been 7, 17, 4, 10, 6, and 12. The epidemic then ceased. The twentieth, twenty-first, and twenty-second weeks yielded but 1, 3, and 2 cases, while the last case of all was noted in the course of the twenty-fifth week.

Variation of Virulence.—It is important to remark that the infection had its full virulence from the beginning. The mortality was heavy from February 23rd, when Case 2 died; yet among those which immediately followed it were some which did not exceed Case 1 in severity. The only change observed in it was enfeeblement. This began about May 1st; it was recognised on comparing the state of patients on admission to hospital after May 1st with the state on admission of those received at corresponding dates of illness before May 1st. Nevertheless, among the majority of cases which, as a whole, testified to this, some which appeared to betoken unimpaired virulence were met with to the very end (see Appendix E, Cases 289, 295, and 303). Another point requires notice in this connection. It is that whereas it had taken seven weeks to furnish the first 100 cases, and four weeks to furnish the second, thirteen weeks elapsed before the 303rd case had been recorded.

TABLE III.—Showing the number of attacks and deaths under Sexes and Age Groups.

Age Group.	—5		—10		—15		—20		—25		—35		—45		—55		—65		—75		Total.	
Sex.	M.	F.	M.	F.	M.	F.	M.	F.	M.	F.	M.	F.	M.	F.	M.	F.	M.	F.	M.	F.	M.	F.
Attacks	8	7	11	6	20	11	49	6	35	7	45	10	46	6	16	4	5	5	4	2	239	64
Deaths...	4	1	1	3	2	3	18	2	15	1	15	1	14	1	10	1	4	4	2	1	85	18

Sex Incidence.—The disease attacked nearly four times as many males (239) as females (64). The slight information available on this head does not indicate any special liability of males to attack in other countries, and probably this special incidence may be accounted for by the stress of the disease having fallen on business portions of the city, and on that part of the population which daily leaves home for some place of employment. This conjecture is supported by consideration of the incidence on the sexes in two infected areas which were distinct from that just referred to, and in which it was nearly equal: on one area, out of fifteen "indigenous" cases (that is to say, cases in which the infection was in all probability received on the spot where the patients lived), only 7 occurred in males, but 8 in females (Paddington); and in another group of nineteen, 10 males were attacked to 9 females (Redfern). Slighter testimony to the same effect may perhaps be drawn from Table III, which shows that the incidence on males and females below 10 and above 55 was much more nearly equal than at the intervening ages.

Age Incidence.—The observed incidence was on ages from 2 years to 74; but more than half the cases occurred in persons at ages between 15 and 35, while more than two-thirds occurred at ages between 15 and 45.

General Fatality.—The total number of cases having been 303, the deaths were 103; the gross fatality was thus just below 34 per cent. But 10 of the patients were Chinese, a race amongst whom the fatality of plague is usually from 80 per cent. upwards; and, in fact, 8 of the 10 died. If these be deducted, the fatality of the disease amongst the remainder, who were all whites, was 32·4 per cent.

Fatality at Age-groups under Sexes.—Table IV shows the percentage fatality of the disease at four age-groups in the two sexes; the smallness of the figures relating to females (see Table III) should be borne in mind.

TABLE IV.—Comparative statement of the fatality among Males and Females at four Age-groups.

Age-groups.	—15	—35	—55	—75
M.	18 per cent.	37 per cent.	39 per cent.	67 per cent.
F.	29 ,,	17 ,,	20 ,,	71 ,,

Fatality, at successive periods.—The fatality of the disease was not uniform throughout the whole series of cases. It was absolutely as shown in the following Table, to form which the 303 cases have been divided into three nearly equal parts :—

TABLE V.—Comparing the fatality of the disease among three arbitrary divisions of the whole series.

100 cases (20 January to 12 April)*	Fatality, 38 per cent.
100 cases (12 April to 8 May)*	Fatality, 35 per cent.
103 cases (8 May to 9 August)	Fatality, 30 per cent.

* The cases which occurred on these days have been divided.

But in this Table the Chinese are included who, for reasons already given are a disturbing element in the calculation, and should be separately dealt with. When they have been excepted, the statement concerning the remaining 293 cases among whites only, assumes the following form :—

TABLE VI.—Comparing the fatality of the disease among three arbitrary divisions of the cases which occurred among whites, the ten Chinese having been deducted as shown below.

	Less Chinese.	
	Cases.	Deaths.
100 cases (20 January to 12 April)*—Fatality, 37 per cent. ...	1	1
100 cases (12 April to 9 May)*—Fatality, 37 per cent. ...	5	4
93 cases (9 May to 9 August)—Fatality, 23 per cent. ...	4	3

* See note to Table V.

A few days after commencement of the term during which the latter 87 cases occurred, Yersin-Roux serum become available, and was thenceforward steadily employed ; but it must be added that, in opinion of the clinical Staff, the virulence of the disease had already begun to abate about the beginning of May. The evidence which can be adduced in support of this judgment is given in Appendices B and E.

Meteorology.—Appendix M consists of a chart on which are described curves constructed from the daily notifications, the rainfall, the daily mean temperature, and the daily mean tension of atmospheric vapour. The data were furnished by the Government Astronomer (Mr. H. C. Russell, C.M.G., F.R.S.)

Suspected Cases.—From January 25th, when the nature of the first case was made known, down to a date long after that last mentioned in Table II, a total of 221 cases of suspected plague were reported to the Department for diagnosis ; 115 of them were referred by 69 medical men, 106 (of which 32 were presented by the patients themselves) through other channels. Many of the latter offered no resemblance to plague in any form, of course ; and many of the former were referred from motives of prudence rather than because doubt as to their nature was really felt. But among these were several cases of glandular swelling, with or without other symptoms of illness. In nearly all of these cases the glandular swelling, could be referred to one or other of the usual causes without difficulty ; but in two or three of them no such cause could be assigned. However, very careful consideration of the recent occupation, place of residence, and habits of these patients, of the history of the illness and of the swelling, and of the results of a minute and prolonged bacteriological investigation, quite failed to furnish support to the notion which had made an accurate diagnosis necessary.

Ambulant Cases.—The suspected cases came to notice in greater number during earlier weeks, and thereafter with gradually diminishing frequency. The probability that the first case recorded was the first case in fact is supported on grounds which are given in detail in Section VI ; and nothing has come to knowledge which would render it probable that either ambulant or pneumonic cases occurred before or during the earlier two-thirds of the time covered by the outbreak. But late in the latter third of that time a few ambulant cases were met with: Case 273, came to notice from the patient himself reporting the serious illness of his daughter, and then mentioning that he had had a somewhat similar attack shortly before; and Cases 299 and 300 (unconnected with each other) were detected after their admission to the Coast Hospital for treatment of the results of an illness (suppuration of inguinal glands) from which they had suffered three and six weeks earlier. So that while the question whether the first recorded case were really the first case which occurred can be answered in the affirmative with great confidence, the further question whether the total recorded cases include all which happened cannot be affirmed without reserve. The accidental discovery of the three just mentioned renders it likely that other such cases occurred in which medical advice never became necessary, or else was sought at a date when the true cause of illness was no longer distinguishable. All that can be said with regard to ambulant cases is that in the general opinion they occurred only at the end of the epidemic, and then were few in number.

Removal to Isolation.—It is convenient to mention here the time which elapsed between notification of cases and their removal to isolation at the Maritime Quarantine Station. The account stands as follows:—

TABLE VII.—Showing the time which elapsed between notification of 303 cases of plague and their removal to isolation.

Removed on the day of notification	154
Removed on the day after notification, to avoid transfer at night ...	99
Removed on the second day after notification, the patients having been too ill on discovery to bear the journey	3
Removed on the fourth day after notification (being the first case, detained at home for investigation)	1
Isolated at country places and not removed to Quarantine	2
First fell ill at Quarantine	7
Died before notification, or immediately after	37
Total	303

253 cases required removal and could be dealt with in the regular way. 154 of them were removed on the day on which they were discovered, while 99 were not removed until the next morning, merely because they had been notified so late in the day that otherwise their transfer must have been effected in darkness.

III.—PROTECTIVE INOCULATION.

Haffkine's prophylactic was alone used. As mentioned below, a small stock had been procured during the latter half of 1899; it was used for protection of those immediately associated with the earlier cases, including the members of the staff. No public inoculation was attempted until a further and large supply came to hand on March 12th. Two considerations governed the manner in which this consignment was expended: First of all persons who lived on, or necessarily frequented areas of known infectivity, had the best right to protection, and the most rational use of the supply was, clearly, inoculation of such persons; secondly, it was impossible (and quite unnecessary) to protect the whole population. But this intention was to a large extent frustrated. Between March 12th and April 2nd, when this supply became exhausted, about 8,000 inoculations were performed, including the small number done before March 12th, which was short of 300. There was then an interval, after which a fresh supply was received, and between May 11th and June 16th, about 2,700 more were done. On this occasion the arrangements made ensured inoculation of a larger proportion of persons considered to be in special danger of infection (see Appendix F., p. 71). Throughout the epidemic inoculation was offered to contacts, either on first being visited, or on arrival at the Maritime Quarantine Station, and the total number segregated having been 1,832, the number then inoculated was 180.

The total number known to have been thus protected was 10,700, all members of the various staffs included; no illness occurred among the latter, except Case 262 (see p. 37), a scavenger at the Quarantine Station who had escaped inoculation, but who was not the only one who was overlooked among the temporary hands employed from time to time. Among the inoculated public, 13 were attacked; particulars are given in the table below. All these patients not merely recovered, but had conspicuously light attacks. The cases occurred almost entirely among the earlier 200, while the virulence of the infection was at its highest, but also among the latter 93 (Chinese being excepted), when it had become feebler.

Table VIII.—Showing the dates on which thirteen persons were inoculated, and the dates on which they were subsequently attacked with plague.

No. of Case.	Date Inoculated.	Interval.	Date attacked by Plague.	No. of Case.	Date Inoculated.	Interval.	Date attacked by Plague.
	1900.		1900.		1900.		1900.
36	20 March.	4 days.	24 March.	57	23 March.	3 days.	26 March.
37	21 ,,	4 ,,	25 ,,	66	23 ,,	6 ,,	29 ,,
41	23 ,,	2 ,,	25 ,,	103	26 ,,	15 ,,	10 April.
42	23 ,,	1 ,,	24 ,,	115	13 ,,	1 ,,	14 March.
44	23 ,,	4 ,,	27 ,,	214	11 May.	0 ,,	11 May.
47	19 ,,	5 ,,	24 ,,	285	21 March.	93 ,,	22 June.
51	23 ,,	7 ,,	30 ,,				

There was one other and fatal case (164), which occurred in a boy who was attacked April 29th, and whose relatives insisted that he had been inoculated; they fixed the time, however, at about two months before attack, when none but those who had been in immediate contact with patients were being done. He was certainly not inoculated at that date, nor before commencement of public inoculation, on March 12th. His name could not be found in the register, which was carefully kept, of the names and ages of all persons inoculated by the staff, and inquiry among his fellow-clerks elicited only a vague statement from one of them, that he had been afraid of the plague, and had said something about a sore arm; this permitted the inference that he had been inoculated, but he had not made any direct statement on the subject. On the whole, the question remained undecided, although the statement made by his relatives is entitled to credence.

The immediate effects of inoculation were, in every case, it is believed, such as are commonly described. A few hours afterwards slight malaise and fever began, with swelling about the seat of the puncture; the feverishness increased, and the night was often restless; there was some slight headache and thirst; the temperature rose in observed cases (the night being excluded) from 2 to 3 degrees. The arm became painful, and after 24 hours there was usually a hard lump around the puncture (which was always made at the back of the upper arm), and rather extensive diffuse swelling below it, with much heat and redness. At the same time there was as much general malaise as might cause an unoccupied person to lie up, but not enough to interfere with important engagements. On or before the third day the malaise disappeared; the redness and diffuse swelling continued somewhat longer, and were attended with stiffness and slight tenderness; the hard central lump gradually diminished and could usually be still detected after from two to three weeks, though free from tenderness during the latter part of the term. The inoculations were always performed by medical men under antiseptic precautions; they were assisted by medical students and laboratory assistants. Not more than three or four cases of suppuration came to knowledge.

The inoculations done were hardly numerous enough to interfere with the natural course of the epidemic; but, in point of fact, no interference could be traced. Whole infected households had never been inoculated. If the person attacked had been inoculated it usually turned out that he alone had been done, often having submitted at instance of his employers; and in households where the patient had not been inoculated it was uncommon to find that even one other person among them had been done.

In accordance with the definition of the word "contacts," which will be found at beginning of Section VII, protective inoculation as a preventive measure to be used among a very large city population consisting of white people alone, and during an epidemic of plague which is under management of an efficient sanitary organisation acting under suitable laws, would appear to be practically restricted to persons who cannot be removed from premises which are known to be infective; to those who, having evacuated the premises during cleansing, are returned to them while the area on which they stand is still infective; and to those who are obliged to frequent infective neighbourhoods, if they will receive it. It will be noticed that attacks which occurred at, or before the lapse of about ten days from, inoculation were not aggravated by it.

IV.—SERUM-TREATMENT.

Yersin-Roux serum became available on May 13th (Case 217). It was administered only by the Visiting Staff to cases diagnosed by them, and at the Maritime Quarantine Hospital. Its employment did not interfere with the natural course of the epidemic.

Although it was intended to give the serum regularly to all admitted to hospital without exception, so as to avoid selection of cases, it was found that this rule could not be adhered to without introducing an equally objectionable influence. The enfeeblement of the infection, which had begun to be observable by about May 1st, led many patients to defer seeking medical advice, and, consequently, to escape notification until comparatively late dates of illness, when they presented very slight symptoms of constitutional disturbance. Thus a dilemma was caused, out of which no way could be found: if the cases were not selected a false impression of the effects of serum-treatment would certainly be given; on the other hand, if they were selected on principles which necessarily could not be strictly defined, the value of the experience would remain doubtful to all but the observer himself.

Fortunately, averages and percentages are statements quite out of place in such connections as this. As a matter of fact, 22 of the 87 admitted after May 12th were not treated for one reason or other—in 9 cases, because the patients either died before discovery, or were then moribund. On the other hand, to the remaining 65 must be added 6 admitted before May 13th, and on that date lying in a nearly desperate state, of whom 4 afterwards died. Among the 71 were many very slight cases; but some account of all of them will be found in Appendix E, p. 70.

The opinion provisionally formed, and expressed subject to consideration of the day of illness on which the treatment began, the mode of administration, and the general features of each case, is that the serum has antitoxic powers which are manifested in useful recovery of the circulation from the depression which is a constant feature of the natural disease; but that in its present state it can hardly be relied upon as a very active curative agent. Probably the dosage requires revision.

V.—ADMINISTRATIVE MEASURES.

Before the plague came the Board and its permanent staff had been watchful and active.

Appearance of the disease at Hongkong was the beginning of general interest in plague as a modern danger, and the beginning of the special interest of the Department in it as one thenceforward threatening Australia. On four occasions during 1894, and twice in 1895 (when it was thought the disease was dying out at Hongkong and the risk nearly past), as well as in 1896, when plague first appeared in India, this danger was discussed, and was made the subject of resolutions and of special directions by the Board. The steadily progressive spread of the disease in epidemic form to other parts of the world was seen soon afterwards to necessitate further precautionary measures, and additional preparations against it.

Possession and first-hand knowledge of the bacillus was clearly a primary condition of success in attempting to guard against the introduction of cases of plague, or to control spread of the disease after it had gained entrance. Accordingly, cultures of it were procured towards the end of 1897, and during the following twelve months its morphological and cultural characteristics were studied in the laboratories. In October, 1898, the Vienna incident became known; the popular impression it caused was obliquely communicated to the Department through official channels, and it was considered expedient to destroy the enfeebled and harmless specimens which then alone remained in the laboratories. At the same time, however, the Board caused a communication to be addressed to the Premier, in which it was pointed out that possession of cultures of the microbe was indispensable to due performance of its appointed functions. During the ensuing year, repeated representations to similar effect were made. But it was not until March 12th, 1900 (Case 14), that formal permission to keep, cultivate, and inoculate this microbe into animals was granted to the Board's micro-biologist by the Department of Lands, which administers the Animals' Infectious Diseases Act, 1888. In the meantime, however, verbal permission to keep, cultivate, and inoculate animals with the microbe of plague had been given by the Premier (March, 1899), and was again given by the Premier (December, 1899) to the President; for it was easy to show that if a suspected case of plague were imported, or occurred on shore, the Department would be in a dilemma in which it must either break the law by making cultures and inoculations, or fail in performance of its duty for want of power to use those means of investigation—means which were open to the rest of the world. It was considered that these permissions, although invalid in law, would suffice to protect the Department in a case where an absolute necessity could be shown. They were relied upon when in October, 1899, it became necessary to examine certain cases which had arrived at Newcastle by the British-India Company's S.S. "Ujina," from Calcutta, *viâ* Port Louis, Mauritius (which turned out not to be cases of plague), and again, in January, 1900, when the first case of plague occurred at Sydney. From this latter, indeed, the cultures in use at the laboratories during the epidemic were in part raised.

During the same term now referred to, namely, from September, 1896, plague had been frequently discussed by the Board in relation to maritime traffic, and had also been a subject of communication between the Board and central health authorities in other parts of Australasia. These communications commenced in January, 1897, and were thenceforward continued. At the end of that year the International Convention which had resulted from the Venice Plague Conference was referred to the Board by the Government; after prolonged consideration it felt obliged to advise that the Government should not adhere to it, the law containing no provision under which the plan of medical inspection permitted by the Convention could be carried out (see Section VII, p. 49). In March, 1898, Madagascar, Mauritius, Réunion, and the Seychelles were proclaimed to be places infected with plague, pre-existing proclamations having covered all other places with which New South Wales has communication, and which had so far been attacked. The gradual infection of a greater and greater number of widely-scattered ports and places was carefully noted, and its bearing on the interests of this port considered; and in October, 1899, the Government was advised to intimate its willingness to adhere to those parts of the Convention which provide for international notification of plague.

Even earlier than the last-mentioned date it had become apparent that, in all probability, Sydney would be attacked; and accordingly in January, 1899, the Board suggested that a member of the staff might be sent to Bombay to study the disease.

The danger which threatened was the importation of plague by sea, and no other. The treatment accorded from the beginning to vessels arriving clean from ports infected with plague (that is, from May, 1894, when plague became epidemic at Hongkong) down to December, 1899, was that accorded to such vessels by an earlier International Convention to clean vessels arriving from cholera-infected ports; a treatment which was also accorded by the Venice Convention to vessels arriving under the conditions now contemplated, that is, from plague-infected ports. But when it was announced that plague was epidemic at Noumea, a town which lies but from three and a-half to six days' steam from Sydney according to the class of vessel making the voyage, it became necessary to alter that method; and, while the regulations laid down in the International Convention were adhered to as far as possible, such vessels were compelled to lie at quarantine after arrival (whatever the state of health of those on board might appear to be) until expiration of the twelfth day from the day of sailing. This term was two days in excess of that prescribed by the International Convention, and was adopted merely because the French Colonial Office had issued instructions to Governors of French Colonies to impose it on vessels arriving at their Governments from plague-infected ports. But, in addition, attempts were made to kill any rats which might still remain on these vessels notwithstanding the efforts to the same end which had usually been made at the port of departure; and sometimes these measures yielded a considerable number of dead rats—in one case, as many as 283. Here it is well to note that the Venice Convention contains no reference whatever to rats, and the share they take in disseminating plague.

Lastly, as regards the measures of precaution and of preparation taken by the Board before the plague actually arrived, a supply of prophylactic was sent for about the middle of 1899; and when the infection of Noumea was announced, it turned out that prophylactic was available in this quarter of the world only at Sydney.

The presence of plague at Noumea in epidemic form was admitted towards the end of December, and the information became known in Sydney by cable on the 24th. On December 28th, 1899, the Board resolved that plague should be added to the list of diseases notifiable under the Public Heath Act, Part III., and it was proclaimed on February 6th. On February 1st, New Caledonia was declared infected with plague; and the Loyalty Islands, and the New Hebrides were declared likely to become so infected, by proclamation. The treatment already described was applied to vessels arriving from the latter groups. A cable message asking for a further supply of prophylactic was transmitted to Bombay.

It became known on December 30th that plague was epidemic at Honolulu, and it was announced that the same treatment would be accorded to vessels arriving thence as to those which came from New Caledonia, if they had communicated with the shore. It was also made publicly known by the Department that imported cases of plague would certainly be stopped at Quarantine, and that they were little dangerous; and it was pointed out that the first defence against the disease, under the circumstances then obtaining, consisted in killing all rats, the second in general scavenging of urban areas.

On January 15th, it was said that there were cases of plague at Adelaide, South Australia.

On January 25th, occurrence of the first case of plague at Sydney was made known. The Registrar-General was at once requested to refer to the Department every information received since beginning of the year, in which the cause of death was ascribed to blood-poisoning, septicæmia, acute abscess, septic intoxication, &c., &c., in order that further inquiry into such cases might be made if occasion appeared; and, since the notification of infectious diseases is by law required only as soon as the medical practitioner in attendance becomes aware that the patient is suffering from one of them, a circular letter was addressed to the medical profession on February 8th, in which a hope was expressed that the strict letter of the law would be exceeded, and that not merely cases of plague, but also cases reasonably suspected to be plague, would be reported by them to the Department (see Appendix N, p. 80); it was also desired that they might be reported direct—not, as the regulations made under the Act require, to local authorities in the first place. Circumstances attending the occurrence of this first case caused the Board to insert advertisements requesting information from owners and occupiers of wharves, stores and warehouses, masters of vessels, scavengers, and the public in general, as to unusual mortality or unusual movement among the rats at places under their control, and attempts were made in other ways to obtain such information. This case having occurred in the city, the President placed himself in communication with the Local Authority, and advised the Town Clerk on January 26th; it was then mentioned that some special scavenging and house-to-house visitation was already in progress. At the same time it was made known by the Department, through the public press, that there was little risk attending the care of plague-patients by the healthy, and the need to kill all rats was again insisted upon, as being the essential preventive measure then practicable. The patient was removed, together with his household and several contacts, to the Maritime Quarantine Station (see Diagram A); and in the report upon it, dated February 7th, it was pointed out, that if cases began to be met with in series, it would be necessary to evacuate the Coast Hospital. All members of the staff, and all who had been brought into contact with this case were inoculated with the prophylactic. The house was disinfected and painted; the contacts were released on the tenth day, the patient on the twenty-fourth day.

When the second case was discovered (February 24th), it was perceived that the fears which the circumstances alluded to above had caused the Department to express a month earlier were about to be realised. The same course was taken in isolating the family as before, but the Board now directed establishment of an ambulance service and of a disinfecting staff at the Quarantine Depôt, Woolloomooloo Bay (see Diagrams); and that temporary equipment of the Quarantine Hospital should be commenced, with a view to transmitting all patients and contacts thither until it should be possible to judge of probabilities in the near future. For it was evident to the Board that if a large number of cases should occur, not merely would the task of fully equipping this hospital for a purpose for which it was never intended, enormously increase the labours of the executive staff, but that it might easily happen that there would not be room enough in the enclosure for all the patients who must accumulate there, and for the nursing and serving staffs as well; while the need to transport all patients to it by sea from a point at the margin of the inhabited area would not merely entail very long journeys on many of them, but would also require organisation of land and water ambulance-services of considerable magnitude.

The infection of Sydney with plague was now officially announced. Once more the Department publicly stated that epidemics of plague were not kept going by communication of the disease from person to person, and again urged a crusade against rats; and it now suggested that a capitation fee should be paid for every dead rat delivered by all except the members of a special rat-catching staff, which should be at once appointed and paid regular wages.

On March 1st, a poster containing advice and instructions to householders was prepared, and subsequently exhibited very freely in conspicuous places all over the metropolitan area; and, notwithstanding the smallness of the Chinese colony, the apparent susceptibility of this race to the disease made it prudent to issue an edition printed in the Chinese language. At a later date (March 29th, case 48) this notice was reprinted in pamphlet form and posted to every householder in the metropolitan area (Appendix II, p. 75).

On March 2nd, the Department announced that for the future it would remove to isolation only actual sufferers from plague, and would quarantine houses and contacts only when the former were overcrowded and filthy, and presumably a source of infection. The plan was disapproved by the Government, which directed strict isolation of all people who had been in contact with plague-patients, and closure of the houses from which they had been removed. This decision subsequently appeared to be in accordance with popular feeling.

In the meantime, local authorities, both in Sydney and elsewhere, had begun to bestir themselves. As regards the City, it was mentioned that special inspection and scavenging had been begun as soon as the rumoured presence of plague at Adelaide became known, and that £2,000 had been thus spent down to February 26th. A house-to-house inspection of the city of Newcastle was carried out at the instance of the Medical Officer of Health for the Hunter River combined Sanitary Districts (Dr. Robert Dick); it had been begun about January 9th, and was reported complete about January 30th. Many metropolitan municipalities also announced the steps they were taking to put their districts in order. The Board gathered together a staff of instructed sanitary inspectors and caused them to visit all municipalities in the metropolitan district, and report (*a*) on the special measures alleged to have been taken or which were being taken; and then (*b*) on the effect produced, as judged after a perambulation of each district, and general inspection of dwellings. About March 2nd, it was stated that the local authority for the City had undertaken the systematic destruction of rats; and on the 9th, it was said, at a meeting of this authority, that 9,000 had already been destroyed. Doubtless, also, there was some private activity in this direction, the Sydney Meat Preserving Company having offered a reward to its workmen for every rat caught on their very extensive premises, as early as February 27th.

Fumigation of coastal vessels, with a view to destruction of rats, had been begun by the several companies at an early date; but a staff to carry out this work on all vessels loading at Sydney, trading between Sydney and other ports and places in New South Wales, or leaving Sydney for other parts of Australia or of the world, was organised and set to work by March 16th. It was placed under a temporary Superintendent of Fumigation, had its headquarters at the Custom House, and was generally supervised by the Collector of Customs (Mr. N. Lockyer). As regards vessels trading within New South Wales, it was ordered that, after leaving Sydney, they must not be allowed to communicate with the shore until they produced a certificate issued to them by the Department stating that the prescribed fumigation had been done while the holds were empty. These regulations worked without causing any serious interruption to traffic (see Appendix I, p. 76).

On March 22nd, regulations prescribing the mooring of vessels at wharves so as to impede the entry of rats to, and the landing of rats from them, were drawn up and recommended to the Attorney-General for gazettal (Appendix K, p. 77); this was done, but it was found that such regulations could be made only under the Wharfage and Tonnage Rates Act, 1880, so that they could be enforced only in the case of vessels mooring at public wharves.

On March 21st (Case 28), the President suggested to the Government that steps should be taken to call a Special Plague Committee into existence. Popular excitement had gradually increased until it had reached a pitch which threatened further serious interference with the Department's practical management of the epidemic. It was thought that such a Committee, if it included the leading members of the community, might steady the popular mind and afford the Department the kind of support in execution of its difficult and anxious duties which seemed about to become indispensable. Nothing resulted from the proposal at that time. But citizens presently began to move in the direction indicated; and on March 28th, the first meeting of a local Sanitary Committee was held in the municipality of Woollahra at instance, and at the house, of the Hon. Edward Pulsford, M.L.C., Mr. John Garland, M.L.A., in the chair. This example soon bore fruit, a similar Committee being called together at the Glebe, by Mr. J. A. Hogue, M.L.A., and a third at Paddington, on April 2nd. On April 11th, the Attorney-General (the Hon. B. R. Wise, Q.C., M.L.A.), attended a public meeting summoned by the Woollahra Committee, and, after explaining the Public Health Act and other sanitary enactments, took occasion to deliver some timely remarks on the indifference theretofore shown by the people in general to their civic duties, and on the tendency, which was universally evident, to rely on the Government not merely for administrative, but for executive, help in every kind of municipal work and responsibility.

The potential usefulness of such Committees was immediately perceived; and on April 11th, a general Committee, to be called the Citizens' Vigilance Committee, was instituted, which was to have a central office and sub-committees in every municipality. Alderman James Graham, M.D., M.L.A., became Chairman, and Messrs. John Garland, M.L.A., and J. J. Cohen, M.L.A., Hon. Secretaries. This Committee which, under its able managers, flourished greatly, and which still continues at work, did an incalculable amount of good in two main directions. In the first place, it laboured for and secured that coöperation of individual householders in the rat-killing business, without which it was plain the best efforts of the Government, and even of municipal councils, could yield but inadequate results; and, secondly, it set about systematically carrying out in every district the recommendation made by the Department on March 1st, in the poster and pamphlet then issued—namely, that every ratepayer should make it a rule to report to the local authority of his district every matter, or premises, which appeared to him to constitute a nuisance and a danger to health. Neglect to faithfully execute the sanitary powers entrusted to them had been a too common rule with many besides the City Council, though within the City its effects were exemplified on the greatest scale; and in the course of a few weeks the result of this scheme began to be evident, not merely in an improved public opinion, but in the changed attitude of all but one of the local authorities referred to. It seems likely that these results, which have flowed almost entirely from the public-spirited and wise exertions of the members and executive of the Citizens' Vigilance Committee, will in important measure prove to be permanent.

From the beginning, it had been gradually becoming clearer and clearer that the origin of the epidemic, as a local event, lay with certain wharves on Darling Harbour. (See Diagrams A, B, and C.) On February 15th (Case 1) and following days these places had been visited in detail by the Medical Officer of Health for the Metropolitan combined Sanitary Districts (Dr. W. G. Armstrong), and owners had been desired by him to take steps to cleanse them, and to destroy the rats about them. On March 11th, the President inspected them in company with the Collector of Customs (Mr. N. Lockyer), and ascertained that very little had been done in the desired direction; he thereupon communicated with occupiers, and threatened that unless large gangs of men were at once put on, and certain specified things done, he would quarantine these wharves. Already it had been perceived that if possible this portion of the city should be evacuated—the first object to be sought under such circumstances being removal of the inhabitants and daily visitors from the apparent focus of infection. But it was the headquarters of a very important branch of trade, and it was thought that this step could not be effectively taken without inflicting a blow on the prosperity of the country (for the welfare of every town would have been affected) which it was little likely to suffer from the epidemic—alarming as the situation was beginning to appear to the public who misconceived of plague as a highly infectious disease, liable at any moment to begin to spread like wildfire. And now two conditions became known, which made some further step than had hitherto been taken imperative. In the first place, while on the one hand it was soon ascertained that wharf-owners in general were not taking the measures which have just been referred to with anything like the requisite energy, it appeared on the other hand that their best efforts could hardly produce the desired results unless business were first stopped, because of the serious structural faults these old wharves exhibited. And then, secondly, the house-to-house inspection of this infected quarter, which was being carried out by the Board's staff of temporary sanitary inspectors, showed that it had fallen into a deplorable state from long-continued omission of the local authority to execute the ample powers to preserve the public health within its district which it enjoyed under its own Act of Incorporation, 1879, and under the Public Health Act, 1896. The result of this maladministration—now for the first time revealed to the general public, though well enough known in several quarters—was precisely that which sanitarians are aware must supervene in every large city, where, though there are good laws, there is an executive authority over a part of it which is at once uninstructed, indifferent, unguided by the routine of an efficient organisation, and ungoverned by strict principles of action.

As soon as these facts were apprehended the Government, after consideration, decided on March 23rd that the parts of the city and the line of wharves referred to, should be mapped out in convenient sub-divisions which should be consecutively closed, and given over to gangs of workmen under its own control. These gangs were to cleanse and disinfect streets, lanes, yards, and the houses inside and out; and, as regards the latter, note was to be made of all which had fallen into disrepair, or were so constructed that they should have been dealt with by the local authority under Part V. of the Public Health Act, with a view to making application for closing orders. The Board, therefore, increased its staff of temporary sanitary inspectors to twenty-eight, placed it under its sanitary inspector (Mr. P. E. Getting), and after furnishing it with a scheme of house-to-house inspection to be filled in and recorded, turned the whole over to the Department of Public Works. Successive portions of the city, which are indicated by dark shading on the three diagrams attached hereto, were closed to traffic and cleansed between March 23rd and July 17th.

Down to about March 23rd (Case 31), the Department had not succeeded—notwithstanding the increasing public alarm—in causing it to be perceived that it was beyond the bounds of possibility that it should not only advise and plan, but also actually supervise unaided all the varied proceedings which on such occasions become necessary. So far it had, by incessant and extraordinary exertions on the part of every member of its permanent and temporary staffs, not only succeeded in the tasks properly arising out of its acknowledged functions, but also in others which did not so arise and which had been silently imposed upon it. But when at this date it appeared to be tacitly assumed that it should supervise the collection, organisation, employment, direction and feeding of a scavenging staff which at the beginning was designed to consist of 1,000 men, and which soon came to number 3,000 men at work at one time, it became necessary to point out not only that this work ought to be intrusted to persons competent in it, but that other subdivisions must be shared out among other public departments which, down to this date (with exception of the Customs, and, as regards the quarantining of individual houses, the Police) had shown little comprehension of the mere physical necessities of the case. From that time forth each took its part. The various branches of the increasing business continued to be smoothly and efficiently worked. The Department was able to turn more attention to its proper occupations, which from the beginning had been sufficient to engross the best energies of every member of the professional staff, weighted as they were with the thousand-and-one interruptions due to popular excitement.

The original supply of prophylactic had been reserved for use in the cases of those persons who had been closely exposed to infection, from their having occupied or frequented the same premises from which cases of plague had been removed; no general public inoculation had, so far, been possible. But on March 12th a fresh supply arrived. Systematic inoculation was begun in the building occupied by the Department. In the morning, ladies and a few other people who came in small numbers, were dealt with upstairs; that part of the general public which lived on, or was employed throughout the day in, the then infected area, was inoculated during the afternoon in the basement. On March 21st, however, the public, without any warning, suddenly arrived in very great numbers, and practically took possession of the building; they invaded the upper part of it, packing the staircases almost beyond possibility of movement, and at imminent risk of a disastrous accident. The building itself was, moreover, unapproachable through the large crowd outside it, which desperately resisted displacement from positions of advantage they had gained near the entrances. The next day, use of the Exhibition Building was granted by the City Council for inoculation purposes. Strenuous efforts were made to restrict public inoculation to those persons who either inhabited the infected area or were obliged to pass the day in it. The medical profession naturally desired that supplies of prophylactic should be placed at its disposal, but, of course, acquiesced in the necessity for restricting its application in the way just mentioned, as soon as it was pointed out; but a portion of the general public were determined to be inoculated at all hazards, though they stood in no known danger of contracting the disease, and very much of this first consignment consequently was wasted. When, at a later date still, a further supply had arrived and the method of inoculation had been organised (Appendix F, p. 71)—being done on this occasion in the basement of the city Town Hall—so entirely had all panic, or even lively interest, in the continued prevalence of the disease died out of the public mind, that between May 11th (Case 215) and June 16th (Case 278) only 2,700 persons presented themselves at the inoculation station, which, consequently, was then closed.

About March 28th it was suggested by the Government that if a new plague hospital were really necessary it should be put up somewhere between the Coast Hospital and Botany North Head, the minimum distance from Sydney thus indicated being 10 miles by road. On March 31st the Board reduced the term of detention of contacts from ten days, at which it had so far stood, to five days; and this was done because it was generally perceived that the former term was unnecessarily long. It was done at this time, however, in order to afford the Quarantine Ground a relief which the accumulation of contacts had made necessary. At the same date the Board once more recommended evacuation of the Coast Hospital; but after deliberation the Government decided that it would be dangerous to remove the patients then in occupation, and, besides, feared it might be necessary to destroy it afterwards if it were used to house plague cases. Not only was the contact camp at Quarantine overcrowded at this date, but the hospital itself was nearly full, being in considerable measure occupied by convalescents. On April 3rd, therefore, a part of the contact-ground and some buildings were transformed as well as possible into a convalescent hospital. This arrangement in turn trenched on the accommodation required for contacts, even after their numbers had been reduced by lessening the term of detention, to an extent which necessitated erection of some fresh buildings; and consequently the Board recommended on April 5th that such new buildings should be at once commenced. This was done. By this time the labour of equipping the hospital, which turned out to be greater even than had been foreseen, had been nearly completed, and as well as circumstances allowed; but only by the hearty and, indeed, self-sacrificing efforts of every member of the staff—medical, nursing, and lay. Quarantine hospitals afford little more than shelter; the buildings in this case happened to be more than usually extensive, but it is not expected—and practically it rarely happens—that more than half-a-dozen persons landed from an infected ship have to be provided for. Its equipment, consequently, and the staff quarters attached to it, little more than suffice to deal with some such small number of persons. There is a vast difference between such an establishment and a hospital which receives a constant stream of patients suffering from an acute fever, and liable to all kinds of serious complications; and which, as a matter of fact, came to house for a long term more than 100 persons at a time. Accommodation for the nursing and serving staffs had to be improvised; they were moreover for months strictly confined to an enclosed area of, perhaps, a couple of acres to a large extent covered with buildings. The only relief which could be afforded the nursing staff was on their journeys to Sydney to attend to the removal of fresh cases, and a rare excursion on the water in one of the launches. It is due entirely to the energy and loyalty not merely of the staffs just mentioned, but of the Superintendent of Quarantine (Mr. James Vincent), and the permanent and temporary staffs under him, that the very great difficulties just adverted to were overcome; and the best evidence of their willing aid is the statement, which can be made without reserve, that whoever else may have suffered, at all events every patient was as comfortably lodged and as carefully tended as could have been the case in the best appointed permanent hospital. The conditions just indicated had been foreseen, and evacuation of the Coast Hospital was recommended in view of them; for by that plan an establishment completely equipped, in going order, and possessing its own ambulance service, would have been rendered available. As it was, the staff of the Coast Hospital had to be very freely drawn upon, in addition to private sources; 18 nurses under Head-nurse Ford were transferred from it to plague duty, whose places had to be hurriedly filled as they best might. Thus the Matron of that Hospital (Miss MacMaster) bore her share in the labours arising out of the epidemic, and succeeded in carrying on the institution very much as usual in spite of the loss of many of the leading members of the staff under her.

On April 17th arrangements were made by which the free distribution of disinfectants to local authorities, which had been going on since March 12th, was supplemented by the free distribution of rat-poison; the Premier also directed that every metropolitan local authority should be empowered to hire at least one man whose duty would be to distribute the poison, to instruct and stimulate householders in its use, to extricate poisoned rats from under floors and other situations in which they had died and become a nuisance, and to destroy the bodies of rats which he himself caught or received. Additionally, a deputation of Members of Parliament urged the Government, on April 11th, to offer a reward for the body of every dead rat delivered to appointed persons; and subsequently a capitation sum of 2d. was so paid. On April 27th, the capitation payment was increased to 6d., and with very satisfactory results as regards the number of rats brought in.

In addition to the measures already described several others were taken, to which but brief reference is necessary. Thus, the powers and duties of local authorities under the Public Health Act, 1896, were explained by the Honourable the Attorney-General, and on March 27th, a circular letter was issued from his Department to all those bodies; and when the deplorable state of some dwelling-houses, and the filthy state of parts of some neighbourhoods, became known in connection with inefficient administration of health laws by some local authorities, he directed that reports upon them should be referred directly to his officers, with a view to taking criminal proceedings against the responsible parties—owners or occupiers as the case might be—in a Court of Quarter Sessions. No such proceedings ever became necessary, but a great amount of cleansing and repairing was speedily effected as soon as they were threatened. So, also, a permanent hospital was erected at Newcastle, on the Stockton Quarantine Reserve, with the probable infection of that port (which is next in importance to Sydney itself) in view.

Local authorities in country districts were requested to secure refusal of a suitable cottage which might be got ready for use in case any person suffering from plague should be imported.

Attempts were made to impart to the public information concerning plague. Dr. Frank Tidswell, M.B. (Syd.), D.P.H. (Camb.), found time to prepare a paper describing the principal epidemiological, clinical, and pathological facts concerning the disease, which was read to a large meeting of the profession at the Royal Society's House on April 27th, and which was reprinted by the Government and suitably distributed. Professor T. P. Anderson Stuart, M.D., LL.D. (Edin.), delivered a popular lecture on plague on April 28th and on May 5th, which was subsequently printed by the Government, and widely distributed; and Dr. Camac Wilkinson, M.D., M.R.C.P. (Lond.), discoursed to the Ladies' Sanitary Association on the same subject on June 5th.

The policy of indiscriminate removal of both patients and contacts was adhered to till the end of the epidemic; patients were strictly isolated from contacts; contacts after bathing and changing to clean clothes were housed in common—that is, without reference to dates of exposure; inoculation was offered to them on arrival at quarantine, but was rarely accepted, and the term of their detention was five days, except quite at the beginning, when it was ten. Convalescents were discharged as soon as (*a*) they had had a normal temperature for ten days, (*b*) provided they had no unhealed sore, and (*c*) were in general respects fit for discharge. The three clergymen who resided at Quarantine and acted as chaplains (Rev. Father le Mesurier from March 22nd; the Rev. J. F. Moran from April 7th; the Rev. Alan McDougal from April 3rd), the medical staff, the consulting medical officer (Mr. C. P. B. Clubbe), and medical men who desired to study the disease, were allowed to enter and leave the hospital enclosure, the former to return to their quarters on the contact ground, the latter to the city, on condition that they had been inoculated, wore a special suit of clothes during the visit, and bathed before resuming their own clothes. The bodies of persons who had died of plague before removal were coffined by a specially engaged undertaker; the joints of the coffin were rendered watertight; the bodies were wrapped in a sheet wet with sublimate solution 1–1,000, the lid was screwed down, the coffin was then enveloped in a coarse cloth wet with sublimate solution, and delivered at the Quarantine Depôt. It was thence transferred to the Maritime Quarantine Station, and there buried without further precaution in sandy soil, on a steep slope falling to cliffs above the Pacific, and at a part of the grounds far removed from that in common use.

VI.—Origin and Mode of Spread.

All those conditions by which the natural course of the epidemic might have been interfered with or modified having now been mentioned, the epidemiology of the outbreak can be studied.

Five or six localities in different parts of the world are known to be endemic seats of plague; the disease has reappeared in them at short intervals during a long series of years, but it has remained confined to them. From one of these endemic seats, situated in the southern province of China called Yun Nan, plague was carried during 1893 along a caravan route to the town of Liao Tchou in the adjoining province of Kwang Si. From Liao Tchou it was transported by two routes. By one, which followed the Canton River, it reached the city of Canton, and became epidemic there in February, 1894; by the other it was carried to the seaport of Pakhoi, on the gulf of Tonquin. Either from Canton or from Pakhoi it reached Hongkong, where it was officially declared to be epidemic in May, 1894. It has been present at Hongkong ever since; in 1895 only forty-five cases were notified, but in 1896 it again became prevalent. During the latter year it reached India, and was officially declared to be epidemic at Bombay in September; subsequently it spread very widely thence, but Calcutta escaped until the Spring of 1898, or, probably, somewhat earlier. The best opinion is that the disease was carried from Hongkong to Bombay by sea.

Trade between Sydney and the ports of Hongkong and Calcutta has been great for many years past. As regards Hongkong two lines of steam vessels both make monthly voyages thither all the year round; the cargo steamers of some other lines sail between the two ports more or less regularly and frequently according to season; while there are in addition many irregular or casual vessels which arrive from China after touching at many places, including Hongkong. So that Sydney has been in danger of importing plague at all events ever since May, 1894; and the invasion of Calcutta, with which communication is frequent, greatly added to that risk. In Mauritius plague was first officially reported on February 27th, 1899, but cases had been observed as early as the previous December which subsequently came to be looked upon as plague; and this island has a steady though small trade with Sydney, which is carried on both by steam and sailing vessels. Kobe, Japan, became infected some time in December, 1899; Honolulu, H.I., on December 12th; and Noumea, the capital of New Caledonia, was officially declared to be infected on December 24th, 1899, when the news reached Sydney by cable. These are the infected places with which Sydney has the most frequent and regular communication, and from which it was consequently most seriously threatened. Lastly it was announced on January 15th, 1900, that certain cases had occurred at Adelaide, South Australia, which were considered to be plague. The detailed accounts, when they came to hand, hardly pourtrayed plague under its clinical or its epidemiological aspects; they lacked adequate bacteriological data, and they contained statements which were unexpected and strange in connection with plague. The rumour, which from the first had been regarded with doubt, was ultimately discredited; and the matter is mentioned here only in order to direct attention to the effect it had in stimulating that professional alertness and public alarm which had already been aroused by news of the infection of Noumea.

Beyond pointing out the several ports from which plague might have been introduced into Sydney, and the great number of vessels which arrive from those ports during each year, nothing can be said as to the way in which the disease actually was introduced. Since 1894 no vessel has arrived which carried, or (as far as very careful examination and questioning on arrival revealed) which had carried, a case of plague in man. Theoretically the infection might be introduced in goods from infected ports; but the lengthy immunity from attack enjoyed by many cities into which goods drawn from infected centres have been daily poured during several years shows that in practice it is at worst very little likely to happen. All that can be said on this point, consequently, is that the first patient was a carman, who was regularly employed by the Central Wharf Co., who was chiefly occupied in carrying exports from city warehouses to Central Wharf [See Diagrams A, B, and C], and who occasionally visited other wharves to fetch packages in course of transhipment. It was ascertained from his employers' books that during 25 days before his attack (January 19th) he had had business at only one other wharf 10 days before attack, that of the Australasian United S. N. Co., Darling Harbour; but between October 21st, 1899, and January 20th, 1900, four vessels which had touched at Hongkong lay at Central Wharf—one of them from January 9th to January 20th. (For a full account of this case, see Appendix L, p. 77.)

Table IX.—Showing the Wharves on Darling Harbour only at which Steamships and Sailing Vessels, which arrived from Plague-infected Ports, lay between October 21st, 1899, and January 20th, 1900. (*See Diagrams.*)

Vessel.	From.	Lying at.........Wharf.	From.	To.
			1899.	1899.
"Prometheus" s.s.	Hongkong	Central Wharf	21 October	29 October.
"Rockton," s.s.	Noumea	Lime-street	28 „	3 November.
"Ching Wo," s.s.	Hongkong	Central Wharf	31 „	7 „
"St. Louis," s.s.	Noumea	Smith's	7 November	11 „
"Kaisow," s.s.	Hongkong	Central Wharf	18 „	23 „
"Rockton," s.s.	Noumea	Lime-street	24 „	29 „
"Moana," s.s.	San Francisco and Honolulu	Union Company's, Margaret-street.	25 „	20 December.
"Peru," barque	Mauritius	Grafton Wharf	27 „	22 „
"St. Antoine," s.s.	Noumea	Smith's and Federal	5 December	23 „
"Umballa," s.s.	Calcutta	Lime-street	15 „	21 „
"Rockton," s.s.	Noumea	„	21 „	29 „
			1900.	1900.
"Ione," barque	Mauritius	Grafton Wharf	6 January	17 January.
"Kintuck," s.s.	Hongkong	Central Wharf	9 „	20 „

The case presented a feature, however, which was taken to show that in all probability the infection had been received neither from an earlier case of plague in man, nor from any infected article. The patient suffered from the disease in the bubonic form, and the bubo appeared in the lowest gland of the vertical chain in the left thigh. In the external retromalleolar hollow of the same extremity was a circular spot, about 3 mm. in diameter; the cutis was purplish red; the cuticle which had been raised was then adherent to it, and at one point only of its circumference it was ragged. This observation (which I made on the third day of illness) suggested that the infection had been communicated by puncture at this spot, and that the inoculation was most likely to have been effected there—at a part of the foot which was well covered by the boot the patient wore—by an insect, namely, by a flea. The inference drawn was that rats were already dead or dying of plague in Sydney, and this formed the motive of the advertisement requesting information regarding disease among, or emigration of, rats which the Board caused to be inserted in the daily papers as soon as the nature of this case had been established, as well as of the prediction then uttered by the Department—namely, that although no cases would arise by communication from Case 1, yet other cases would probably be met with.

The full justification which this view subsequently received, supports an opinion that the disease was not introduced either by some unobserved imported case in man, or by importation of infected articles, but by infected rats; from which it spread to the local rats which, in turn, communicated it first to Case 1, and, as will subsequently appear, to other persons afterwards. But by what vessel, or from which infected port, such rats were landed at Sydney, there is no evidence. It may be pointed out, however, that communication with the remoter infected places had been extensive, and steadily maintained for long previously without introduction of the infection; and that the latter gained a footing only after the disease had appeared at Noumea, a port which lay close at hand. No official account of the epidemic in New Caledonia has yet been published; the following remarks must therefore be regarded as conjectural to some extent. The first case in man must have happened in New Caledonia some time before the presence of plague was acknowledged on December 24th; and it may have happened considerably before that date. But appearance of the disease among rats, not among the inhabitants, has most interest in relation to risk of importing the infection. Now, it was reported that the rats at Noumea suffered heavily during the epidemic; but the important question whether the epizoötic preceded the epidemic, cannot at present be positively answered, no authoritative information on this point having become available. A frequent experience, however, is that the rats suffer first, and usually several weeks before appearance of the first case in man. If this happened at Noumea there was nothing to prevent importation thence at any time prior to December 24th, for no special precautions were or could be taken at Sydney until after that date, when the disease was first officially admitted to be present there in man.

No information concerning mortality among rats was furnished in response to the advertisement mentioned above nor to other inquiries until February 14th, when an officer in the Customs Department drew attention through the Collector to unusually frequent deaths among them at Huddart, Parker, & Co.'s Wharf, on the eastern side of Darling Harbour (see Diagrams). The wharf being within the city, the President caused the local authority to be informed and advised, and in the course of the afternoon four live rats and three carcases were brought to the laboratories by the Chief Inspector of Nuisances for the city, who said it had taken him two hours to find them. At a later date an inspector of fruit in the Department of Mines and Agriculture reported that he had noticed an unusual mortality among the rats at Huddart, Parker, & Co.'s Wharf about the first week in January. Nothing further on this head has been discovered; and it is important to note that no suggestion that rats were suffering from an epizoötic at any other part of Sydney about or before the dates referred to has ever been made. The beginning of an epizoötic among rats occurred at wharves on the eastern side of Darling Harbour, and it first became manifest at Huddart, Parker, & Co.'s Wharf.

The seven rats above mentioned were at once utilised for the usual bacteriological and inoculation tests, and were shown conclusively to have been suffering from plague. At the same time, glands which had been removed from the body of a man who had died the previous day were brought to the laboratories, and on examination showed with sufficient certainty under the known circumstances that the cause of death had been plague. The beginnings of an epidemic are so important that an account of Case 2, as well as of a few others of the earlier cases, is necessary. The patient had been attacked about February 17th. In the course of his brief illness he had been attended by three medical men, of whom two were called in consultation, not because of the apparent gravity of his case, but for reasons which can be inferred from what follows. A clear history of injury to the lower abdomen received three or four days before attack, and caused by a fall against a plank, was given. The disease was recognised as having the form of septic fever; but no peritonitis or other occasional consequence of such an injury could be made out and, in fact, there was none. The illness was well marked, though as it seemed, not immediately dangerous to life. Death occurred unexpectedly. It was then that plague was judiciously suspected, and that inguinal glands which had become enlarged and painful in the neighbourhood of the seat of injury were removed, and brought to the laboratories for examination at about 3·30 p.m. This patient, who died at his house in a suburb, was a sailmaker. His business is said to have been exclusively among locally-owned craft, and all connection with vessels coming foreign was denied for him by his survivors. He occupied a sail-loft on the water side of Sussex-street, not above 200 yards south of Huddart, Parker, & Co.'s Wharf, where he employed about forty workpeople, men and women. He had also a large household, part of which, at all events, had for some time lived at the workshop with him. As soon as the examination of the glands had been carried sufficiently far, the workshop was placed in quarantine at about 4·45 in the afternoon and, of course, without warning. On being questioned at that time as to the presence of rats there, the inmates said that deceased had removed five dead rats from a water-closet on the same floor two or three days before his attack. This closet was connected in a primitive fashion with a short pipe-drain which discharged under a wharf at the back of the house. No illness occurred either among the members of the family who had been as much associated with these premises as the deceased, nor among the many workpeople who were regularly employed there. No illness occurred, either, among the frequenters of the three premises above which the sail-loft ran, two of which were occupied by a produce salesman, and the other as a merchant's office; however, they were entirely cut off from the sail-loft, which had a separate entrance from the street.

Case 3 was notified by the medical man in attendance the next day (February 24th.) The patient lived on the western side of Darling Harbour, at Pyrmont, but he was a wharf labourer employed at Huddart, Parker, & Co.'s wharf. There was no history of dead rats at his dwelling, nor anywhere in the neighbourhood of it. This patient had a household of six persons, among whom no illness occurred.

Case 4 was notified on February 28th. The patient was a labourer in employment of a produce dealer who lived at the Glebe. He had not been anywhere near Darling Harbour for at least a fortnight before attack; but the supplies for the shop at which he worked all day were in large measure drawn either from Huddart, Parker, & Co.'s wharf, or from another close to it, at the back of the house occupied by Case 2, where the bales of hay, sacks of potatoes, &c., &c., often lay for several days before being delivered. In this case the disease could not be attributed to rats seen; and it may be suggested that the infection was conveyed adherent to some of the articles mentioned. The patient himself was too ill when first visited to speak as to presence or absence of rats, dead or alive, from the bales and sacks which he unpacked. No illness occurred either among his employer's family, or at the house (in a street a mile away) where he lived, and whence ten persons were transferred to observation.

Case 5, notified on March 2nd, occurred in a publican whose house was immediately opposite Huddart, Parker, & Co.'s wharf, and was overrun with rats. No case occurred among the other sixteen members of the household, who were removed to observation.

Case 6 occurred in a boy aged 8, who lived with his uncle and aunt and two other children in a house in Kippax-street, Belmore Park, and was notified on March 7th. No other case occurred in this street until eight weeks later (Case 180); it then seemed probable that the neighbourhood had become infected by extension from the focus to be mentioned in connection with the next case, though at the time of notification Case 6 could not be in any way connected with a probable source of infection. The house was not used for any business. The patient's uncle (who was not attacked) was employed by a butcher whose shop lay not very far away, but in a neighbourhood which yielded no indigenous cases until long afterwards. It seemed that the child himself did not go far from home except to school. There had been rats on the premises, but they had been killed off about four months before by dogs obtained for the purpose, and there was no history of dead rats having been seen.

Case 7, which is the last which need be here mentioned in detail, occurred on March 8th, in a boy about 2 years old. His parents lived in a cottage which is indicated on the three diagrams by a cluster of five dots which represent the five cases which occurred in this family. The cottage stood in the neighbourhood of the City Corporation tip at Moore Park, a place where all the garbage and street-sweepings of the city are still dumped. To this spot refuse from the neighbourhood of the infected as well as other wharves was carried for some time after the fact of infection became known. There is no difficulty in showing clearly enough that the part of Sydney in this neighbourhood became subsequently a focus of infection which yielded many indigenous cases, of which the present was the first. The circumstances attending this case were the following:—The family consisted of the parents and six children. The cottage had had a good many rats about it; and in an outhouse in which the younger children used to play, one or two dead rats were discovered when, after attack of Case 7, it was cleaned out by the father. On these premises, also, the disinfecting staff found quite an extraordinary number of fleas; the bodies of the younger children were almost literally covered with their punctures. The only persons attacked were four young children who habitually played in the outhouse, and the father who cleaned it; they had none of them visited the garbage tip. All but the youngest child recovered.

The progress of the epidemic in point of time has already been described in Section II; its progress in place may be gathered from the diagrams lettered A, B, and C, which are appended. These diagrams have been constructed as follows:—In all three each case noted is represented by a dot; the dots are printed in four colours, each of which is appropriated to a period of time; thus black indicates the cases which occurred between January 20th and March 24th (Case 32); green, those which occurred between March 25th and April 21st (Case 129); red, those which occurred between April 22nd and May 19th (Case 239); and blue, those which occurred between May 20th and August 9th (Case 303), the end of the epidemic. On Diagram A the spots are so placed as to indicate the houses from which patients *were removed*, or, if they were actually removed from a general hospital, those they had occupied before admission to such hospital. On Diagram B they indicate the places at which the patients *were employed* during the time which covered the date of their infection; a working limit to latency—probably correct also—of five days being assumed, although of course the duration of employment at the place before attack had usually been lengthy. On Diagram C they indicate the probable *place of infection*, which was sometimes the residence, and sometimes the place of employment. The manner in which this place was fixed upon requires describing.

If Diagram A be examined, and if for the sake of clearness attention be confined to the black dots on it, which represent the places from which those cases which occurred between January 20th and March 24th were removed, it will be seen at once that the components of the series were not related by neighbourhood; for although one household afforded five cases, and although at another point six separate households appear close together, speaking generally the black spots are distant, and in several instances very distant, from each other. Secondly, it was ascertained that the members of these infected households were in all cases unacquainted with each other. Thirdly, the patients themselves were unacquainted with each other, except in certain instances in which they were associated at their place of employment or at home (Case 7). Hence it appeared that neither locality of habitation, nor personal communication, was the essential factor in infection. But the observed association of certain cases at their place of employment made it necessary to rearrange the diagram so as to show place of employment instead of the place of residence (see Diagram B); and this having been done, it appeared at once that the black spots were drawn much closer together, and were largely concentrated about Huddart, Parker & Co.'s wharf, and the eastern shore of Darling Harbour, although several of them still remained outlying.

It must be remembered that the time represented by the colour black was considerable (thirty days exclusive of Case 1) and that elucidation of the place of infection lay in reality with the circumstances surrounding the earlier cases of this period; and then, secondly, that the nature of our possible source of local infection had been established at an early date. It did not consist in an infection of the soil; no other reason in support of that supposition could be given than an assumed automatic commencement of specific infectivity of it, which, of course, is absurd. On the other hand it was already known to be present in the rats of the locality. Now rats are not confined in place, but can wander, and in accordance with their known habits were sure to occupy a wider area, or to migrate to different areas as time went on; and hence the black spots on Diagram B are concentrated about the original focus of infection only as regards the earlier numbers of the series, and even then with exception of Cases 4, 6, and 7. In fact, towards the end of the series indigenous cases began to appear at points rather far removed from the original focus (Case 20 at Rowe-street, City, 22 at Windmill-street, City, 23 at Walker-street, on the Redfern focus); and then, as time went on, cases began to be met with in which, although in some instances the patient was employed in or close to the original focus of infection, his case could not reasonably be referred to his place of employment on account of cessation of the neighbourhood it indicated to furnish a succession of fresh cases—because, in short, that focus had ceased to be dangerous. Also, other cases in persons who never had been near the original focus, and who had not been away from their place of residence, began to be met with in appreciable proportion (women and children especially), and with the neighbourhoods in which these occurred some of the cases just before referred to were associated. It became apparent, after careful study of all the circumstances, that fresh foci of infection had become established, and that it was no longer possible (as at first it had been) to assert *a priori* that wherever a patient might be found it would probably be ascertained on inquiry that he was in some way associated with the eastern side of Darling Harbour. The dissociation of these later cases both in place of residence and in personal communication continued to be as conspicuous as at first; if they lived in the same neighbourhood still their houses were more or less distant from each other, and although they might all possibly have encountered each other in the streets, by far the most often they were unacquainted. Consequently these neighbourhoods gradually became distinguishable, and entitled to be designated fresh foci; and as soon as this conclusion presented itself the same relation between them and the presence of diseased rats in them was observed, as had been first observed at the original focus. In many cases the evidence consisted merely in the reported observation of an unusual number of rats, and of dead rats, or of the death of rats in unusual places—under floors, in cupboards, or outhouses, &c.; but in some cases, elsewhere mentioned more particularly, it consisted in actual detection of plague in sick or dead rats, or (in one case) in a cat. Thus Diagram C, which represents the probable place of infection, was constructed from the whole of the facts concerning each case, after they had been weighed. It is in reality, therefore, an expression of opinion—very carefully formed, it is true, but not to be taken in all respects as a representation of ascertained fact; and that is the reason why Diagrams A and B (which state ascertained facts only) are presented along with Diagram C.

On Diagram C the black dots are shown almost entirely gathered together on the eastern side of Darling Harbour, and at the northern end of that shore. Cases 4 and 7 still occupy the positions originally assigned them—in other words have still to be regarded as indigenous to those places, or, at least, as having no personal connection with the original focus; and now Case 23 appears at Walker-street, Redfern, due west of the five dots indicating Case 7. It is the first in immediate relation to Case 7, and the garbage tip at Moore Park, and is seen to have belonged to a considerable collection of cases which occurred thereabouts at later dates. And thus, perhaps, a hint of a possible source of the infection received by Case 6 (Diagram A) is indicated; far as he lived from any area known at the date of his attack to be infected, he attended Bullanaming-street School, and to reach it crossed the area on which Case 23 occurred. To later extension from that area are also ascribed the cases to the north which are marked about the words "Surry Hills," east from Redfern terminus. These patients had no concern with Darling Harbour, nor even with any neighbouring part of the City.

To further illustrate the course taken by the infection in spreading to various neighbourhoods, it can be pointed out in relation to the black spot which indicates Case 4 that a green and two blue spots appear near it on Diagram C; not in very close contiguity to it, considering that the locality is closely covered with streets and houses, but still near it. These two colours respectively indicate the period which followed on that indicated by black, and the last period of all. A similar sequence of events might be described in relation to two or three other congeries of spots of different colours which appear on Diagram C. It might be suggested, therefore, that wherever one case of plague occurs there, or thereabouts, other cases may be expected. But the black spot attached to Case 4 indicates the place where the patient was employed; he did not lie ill there, and being attacked suddenly at midnight at his own house a mile away, which he did not leave thereafter except for isolation, he was not even on the premises while suffering, and therefore he could not have been the source of infection for the cases indicated by the green and blue spots, however indirectly. And, in fact, those cases belong to an extension of the infected area at the head of Darling Harbour.

From the head of Darling Harbour the infection spread to the neighbourhood of Redfern terminus, and thence in a south-westerly direction; a rat brought from the house indicated by a green dot towards the western end of Cleveland street and just above the words "Vine-street," as early as March 26th (Case 35) was ascertained to have died of plague. It did not cross the terminus, nor the railway lines to the south, nor the open spaces to the north of it. It proceeded from the terminus along George-street West, to be revealed in part by the cases referred to above as standing near the place at which Case 4 was employed; but it is possible, although, considering the lie of the country not so likely, that it reached this latter neighbourhood on a south-westerly course from the head of Darling Harbour; whence also at a much later date the indigenous cases shown on the promontory marked Pyrmont in all probability derived their infection. The green spots show that the above extensions occurred at all events before April 21st (Case 129).

Reverting now to the original focus, no less than 115 cases, or 38 per cent. of the total number are ascribed on diagram C to the area enclosed by Liverpool-street (running east from near the head of Darling Harbour), Elizabeth-street which intersects it, and a line drawn at right angles to a line produced from the northern end of that street in a northerly direction, so as to run westerly through the words "Bridge-street" and "Charlotte Place" to Darling Harbour again. Black spots (first period) are there seen only near the water; green spots (second period) are in a majority, and are present at the water's edge, but they also appear to the east of the black spot area; there are only two red spots (third period) close to the water, and to the east they far outnumber the green spots; there are but few blue spots (fourth and concluding period), and they chiefly appear at points far removed from any part of this area. As these four colours represent four divisions of the time over which the whole outbreak lasted, they indicate the direction in which the infection extended on this the most heavily stricken area of all, and indicate it very accurately. It appeared at the water's edge; it travelled easterly thence up the ridge which runs north and south parallel with Darling Harbour, and which culminates on the line of York-street; down the other side of this ridge to George-street; and up the ridge on the eastern side of George-street, as far as Elizabeth-street. There it was abruptly stayed; on the easterly side of Elizabeth-street, beginning at the intersection of Liverpool-street, are the uninhabited spaces marked on the diagrams. They are parks, or spaces on the margin of the parks occupied only with public buildings, and they stretch quite to the water at Bennelong Point, the northerly point of their westerly boundary being indicated by the line of Macquarie-street.

At a later date the infection did travel east of Elizabeth-street; perhaps closely round the southern end of the continuous open spaces just mentioned, but more probably from about Campbell and Hay streets (north of Redfern terminus). There was a distinct sub-centre of infection at that neighbourhood, to the south of Oxford-street, through which "Napier-street" runs; the building at the corner of Oxford and Dowling streets, marked by a red dot, being a brewery.

A quite separate focus which requires description became established at Manly. This place is a village situated on a neck of land at the northern end of the harbour, so that it has frontages both to the harbour and to the Pacific (see diagram A);

A); it contains about 3,000 inhabitants, many of whom travel daily to Sydney, and it is a favourite holiday resort which is visited by several thousand persons from Sydney every Saturday afternoon and Sunday. It can be reached by crossing from Circular Quay to Milson's Point, and following a road for thirteen miles, in the course of which the water must be crossed once more. This route is little used as a means of reaching Manly, although—a point of some importance—it is taken occasionally by waggons carrying heavy goods such, for instance, as furniture. The usual route is by ferry from Circular Quay; the distance being then seven miles, and the time occupied about half-an-hour. These ferry-boats convey considerable quantities of stores, including butcher's meat, every day. They lie at the wharves at either end between journeys and at night. From a misunderstanding, it happened that fumigation of these vessels to destroy rats on them, was not begun at the same time as on the ferries which plied from wharves on Darling Harbour.

The ferry runs to a single pier at Manly, on which are the usual sheltersheds, and at the end nearest the shore a refreshment-room. The lessee had been allowed to convert a part of the structure into a dwelling, for which it was quite unsuited.

On May 1st, the case (163) of a man who kept a tobacconist's shop about 150 yards from the pier was notified. He had visited two warehouses in the immediate neighbourhood of the original focus five days before attack. This shop was subsequently demolished, and then many dead rats were found under the floor. On May 2nd the case (175) of a rouseabout at a public-house about six doors from the foregoing shop was notified. He slept in a shed at the rear of the hotel, getting his meals in return for his casual services, and hung about the pier when he was not wanted at the hotel. This person had not been away from Manly for many days before. On April 28th he removed several dead rats from the cellar of the hotel, on which premises no poison had been laid. On May 11th the case (213) of a vanman who lived in a street within a short distance of the pier, and who plied almost entirely at it, was notified; and the next day that of a girl (217) who was employed at the refreshment-room on the pier. This place was lined with matched-boarding and had a false floor; from this cover about thirty dead rats were removed during disinfection. On the 20th a boy who was practically unemployed, and who was always to be found at the pier if he were wanted to carry a message, was attacked with and died of plague (242). On May 29th the first of two cases in children (253), which occurred at livery stables just across the road from the pier, was notified; the house was emptied and disinfected May 30th, the family returned June 5th, and on June 25th the second case (288) occurred, the first being still in hospital; and between these two, on June 5th, the case of an ostler at another public-house opposite the pier was reported (257). The infected area was closed for general cleansing; and on July 12th, while this was still in progress, the case (298) of a man employed on the scavenging staff was notified. His place of residence was at Manly, but a mile and a quarter away from the neighbourhood of the pier.

Association of most of these cases with the pier is evident; but the first patient (163) had no other communication with it than consisted in frequently walking across it to the ferry-boat; while 175, 253 and 288, and 257 did not frequent it, although in the case of the two children it is likely they were often there. But 298 certainly had no particular communication with it, and, in fact, was infected only long after all the others (seventeen days), and only in the course of scavenging the area on which other cases had resided and (possibly, though not probably, with exception of 163) had been infected. Apparently, then, the infection, although communicated to persons who either frequented the pier or visited it casually more or less often, was not confined to it. On the other hand, it extended only to a short distance from it, and was markedly associated with presence of dead rats. Some of them, however, may have died of poison.

As soon as the first case was notified rats were sought at the pier and in its neighbourhood; nineteen were delivered at the laboratories, and all of them showed signs of disease. In eighteen of them, however, this could not be identified with plague (the bodies were very often more or less putrid), the signs consisting mainly in enlargement of the liver and spleen, and it seemed possible that these changes might have been the effect of poison (phosphorus for the most part), which had several weeks before been supplied to the local authority. Nevertheless, experience having already shown that where plague occurred in man there plague in rats existed and could usually be discovered, the tedious bacteriological search was continued until in the nineteenth rat (and in two others afterwards) plague was demonstrated.

This localised outbreak has many attractive features. Although in constant and unusually free communication with Sydney, the place escaped infection until the eleventh week of the epidemic. The occurrence of cases, and therefore the distribution of the infection, was limited to a very small area; an extremely small proportion of the persons living on and passing through that area was attacked, so that it seems that in addition to presence of infection some accidental, and not commonly existing condition was necessary to enable its communication to man. The pier seemed to be the gate by which the infection entered the place, and the special connection of several of the patients with it indicated that it was perhaps the centre of infection, or the most dangerous point of the small area. Lastly, so long as seventeen days after the last case occurred, and the area had therefore begun to be regarded as clean, it was discovered on sufficient search, namely in the course of scavenging operations, that infection still lurked in it. The discovery of plague-rats, and of a large number of dead rats at the pier refreshment-room and elsewhere, showed that plague infection was present on the area in rats, if nowhere else; and consideration of the points summarised above, together with the evidence which is later given that the disease was not communicated directly or (with a single exception) mediately from man, shows that a hypothesis on which the infection is assumed to have been introduced, and to have been spread, by rats comports so well with them that no other source of infection for man need be conjectured.

North Sydney is considered never to have become infected, although six households, shown only on Diagram A yielded cases. These, from which there was no extension of the disease were ascribed, with one exception, to infection received on the chief area in Sydney, where the patients were employed. The exception was the case of a baker's man, whose movements outside North Sydney could not be ascertained, and the source of whose infection was left undetermined.

The apparent spread of infection in Sydney itself need hardly be further traced. It will be seen from Diagram C that indigenous cases are set down far along the course of Oxford-street, the important thoroughfare which runs easterly from the city; along Parramatta-road, the main thoroughfare which runs westerly from the city; and along Botany-road, the main, but much less frequented, thoroughfare which runs southerly from the city. At some of these more distant places plague rats were identified or, as in one case, a plague-stricken cat (see diagram B); while at others there was often a history of dead rats, verified in 70 cases by the disinfecting staff. But it must be noted here that a spot map does not show details; and some of these distant cases are set down as indigenous with hesitation, in as far as the epithet implies—as, in its present use, it is intended to imply—local presence of the infection in rats, and therefore in an automatically transportable form. In a few of them it was clearly possible, as far as ordinary surrounding circumstances went, that the infection might have been introduced together with goods derived from the central infected area; but whether such goods carried deposited infection, or whether they merely harboured infected rats, dead or alive, is a question for the present reserved.

The general outcome of the foregoing examination of the manner in which the 303 cases of plague were situated and successively occurred on the whole area, is to suggest that the infection was in some way or other connected with place. Frequent references have been made to the ascertained presence of dead and of plague rats in this or that neighbourhood; but this has been almost unavoidable, and has not been intended to prejudice the case for other modes of infection, which are known to have operated elsewhere, and one of which, at all events, was seen in operation (in a single instance, Case 262, p. 37) at the Maritime Quarantine Station. And therefore the mode in which the disease actually did spread will now be examined from other points of view.

If the three diagrams be examined in general, it will be apparent on a little reflection that the conditions represented could be produced only by three causes, apart from infection of locality: These are infected water, infected food, and infected persons.

The two former can be certainly excluded without difficulty. The bacillus of plague can survive in water for short terms, which vary with the kind of water used (sterilised, distilled, main, or sea water); this knowledge, however, has been gained experimentally (except one observation on sea water), and it has not yet been noted whether plague can be communicated to animals from water carrying plague-bacilli. What is more to the purpose is that while the epidemic spread of plague by town water supplies has never been suggested, the accounts returned from several different parts of the world do not furnish the least ground for suspecting that it may have happened. As regards Sydney, it is enough to point out (*a*) that a very much larger area than that included in Diagram A is supplied from one primary source; (*b*) that while the water from this single source is pumped to, and distributed from, subsidiary reservoirs, more than one such reservoir must have been contaminated to account for the observed distribution of cases; and (*c*) that Manly has its own source of supply, entirely distinct from the former. Secondly, as regards distribution of the infection by food in any form, it is now generally admitted that the disease is rarely communicated to man by feeding; there is no reason for suspecting that this mode can have been a factor in any epidemic prevalence of the disease hitherto observed.

Remains, then, only habitual communication from person to person as a possible cause of the Sydney epidemic. This might be brought about directly or by mediate channels: the infection might pass directly from the sick to the well; or it might be communicated from the sick person to some place or object, whence the second patient could receive the disease without having seen, or even become aware of the existence of, the primary case. These are ways in which epidemics are known to be sometimes caused (of small-pox or scarlet fever, for instance). Whether they had any important share in contributing to cause the Sydney outbreak of plague is the question now to be examined. But, first, the difference there is between the possible communication of disease by one or other means realised only from time to time and rarely, and such a usual communication of it as alone can cause epidemic prevalences, must be referred to. All preventible disease should be prevented; and, therefore, if special dangers exist they should be guarded against by precautions specially taken against them. The first object, however, is to prevent epidemic prevalences; afterwards, the occasional causes of exceptional occurrences of the disease can be considered and steps taken to prevent even them.

In the first place, it may be inquired whether the facts furnish any reason for suspecting that infection mediately communicated from man was the cause, or an important contributory cause, of the epidemic.

How could such mediate infection operate effectively? Only by habitual diffusion of household goods. Only in this way could articles which had been in contact with, and which had received the infection from, the sick, be brought sufficiently often into contact with healthy persons; and such contact to have been a factor in the epidemic must have taken effect on persons outside the house occupied by the primary patient. Firstly, then, the infected households were much the most often those of respectable working-people who carried on no business at home, but who left home every day for some place of employment. These are not the people whose household belongings are commonly liable to wide diffusion; but if they were, the suddenness with which this disease usually attacks must be remembered, and that it would be singular if the first few days of an illness which was almost always alarming from the first, were chosen for such diffusion. Secondly, although in order to cause an epidemic spread of disease such communication must be between the primary household and others, yet, if it could take effect on the latter, much more should it take effect within the primary household itself; but it will be seen directly that only 10 altogether out of 276 households yielded secondary cases, and those occurred under circumstances so different that they cannot be classed together. If, then, mediate infection played so small a part (if any) within households, it could not have played a larger part outside them. One other possibility remains open, namely, unconscious diffusion of the infection by means of articles of commerce handled by the sick. Here, again, the suddenness of attack must be referred to. Persons did not, and, for the most part, could not, remain at work a moment after onset of the disease, and until then they were incapable of communicating the infection. However, in the following table the occupations of the 303 patients are classified and presented :—

TABLE X.—Occupations of persons attacked.

Occupation.	Male.	Female.	Total.	
Food Trades :—				
Hotels and Public Houses	7	6	13	
Butchers	3	1	4	
Fishmongers	2	...	2	
Fruiterers	4	...	4	
Restaurants, Cooks, Waiters, &c.... ..	6	3	9	
Bakers	2	...	2	
Provision Stores	14	...	14	
Produce Stores	14	2	16	64
Other Trades :—				
Carters and Horse Tenders	12	...	12	
Bootmakers	3	...	3	
Carpenters	6	...	6	
Ironworkers...	5	...	5	
Painters and Plumbers	6	...	6	
Printers and Bookbinders	19	...	19	
Tailors, Drapers, and Shop Assistants ..	6	3	9	
Warehouses	16	...	16	76
Labouring Work :—				
Timber Yards	6	...	6	
Labourers (Miscellaneous)	19	...	19	
Wharf Labourers	11	...	11	36
House Work :—				
Domestic Duties (including servants and children at home)	26	45	71	71
Miscellaneous Occupations	32	2	34	
No Occupation	10	2	12	
Chinese	10	...	10	56
Total	......	......		303

Mediate infection as a cause of the epidemic may be excluded then, and without hesitation ; the question of possible spread from man to man by intermediate animate objects being for the present reserved. The possibility that direct communication of the infection from the sick to the healthy was the cause of the epidemic spread of the disease now alone remains ; it must be examined with care.

Two sets of facts furnish the requisite evidence. In the first place, those which concern the total cases will show whether the persons who did contract the disease got it from preceding cases; and secondly, the fate of those who were in contact (usually household contact) with the sick will show in what degree (if any) it was communicated to them.

The first statement is as follows:—There were 303 cases altogether; but thirteen were secondary cases which occurred in ten households; so 290 households yielded 303 cases. Four of the 303, however, occurred in members of scavenging gangs while they were at work on the area to be scavenged; these, though actually in contact with large numbers of people, cannot be reckoned as belonging to households. Four cases and four households must be deducted, therefore; and the statement then is, that 286 households yielded 299 cases (it is true, also, that several of the 299 had no fixed place of abode – but they had usually been in known contact subsequent to attack with more or fewer persons among whom no illness occurred, so that it is not worth while to complicate this statement by excepting them). But a further deduction must be made of ten Chinese who occupied ten different dwellings, because too little (and that untrustworthy) could be learned concerning them. So the nett statement, which applies to whites only, is that it took 276 households to furnish 289 cases. This by itself is sufficient to show that direct communication of the infection from the sick to the well could have occurred but rarely, and even exceptionally.

Among the cases just mentioned were some persons who, after receiving the infection at Sydney, travelled to more or less remote towns and there fell ill, from none of whom was there any extension of the disease. Particulars of these cases are given in the table below:—

TABLE XI.—Showing the number of persons who left Sydney and were attacked at distant places within five days thereafter.

No. of Case.	Residence in Sydney.	Left Sydney.	Arrived at.	On.	Distance from Sydney.	Was attacked.	No. of Contacts.
115	Balmain	April 13	Goulburn	April 13	134 m.	April 14	9
127	Balmain	,, 18	Menangle	,, 19	41 ,,	,, 20	1
154	Paddington	,, 23	Glenfield	,, 23	26 ,,	,, 25	5
166	Surry Hills	,, 28	Ballina	,, 30	331 ,,	,, 27	56
264	Pitt-street, City	May 30	Mittagong	May 30	77 ,,	May 26	4
...	Fireman, s.s. "South Australian"	April 3	Melbourne*	April 7	576 ,,	April 5	...
...	Fireman, s.s. "Gera"	May 5	Adelaide*	May 10	1,074 ,,	May 10	...

* Reported from these ports, where the vessels were held in Quarantine.

But it will already have been perceived that several other cases, which are precisely similar to those in Table XI, except in the comparative shortness of the distance to which they travelled from the centre, occurred within the metropolitan district (see Diagram A).

These particulars, which have been cited as evidence that the disease never within our experience was set going by the arrival at uninfected places of persons who fell ill shortly after, introduce the second set of witnesses which consists of those who lived for a time in contact with others who had the disease. Attention is here drawn to the statement already made that although inoculation was offered to contacts it was seldom accepted by them; to which it may now be added, that the total persons among the contacts (total 1,832) who were inoculated, either before being sent to isolation or on arrival there, was so small (180) that they may be left out of account in this connection. Further, it has already appeared from Table VII, that isolation followed very speedily on notification, and it may now be asked whether the contacts had remained in communication with the primary patient sufficiently long to contract the disease from him, if so it might be contracted. But the duration of exposure to the infection was the interval which elapsed not between notification and removal, but between attack and notification; and what this was is shown for each of the 289 cases in the following table:—

TABLE XII.—Showing the day of illness on which 289 patients and households were removed to isolation. Also the number of secondary cases which occurred after isolation in four households.

Day of Illness.	No. of Cases.	No. of Contacts.	No. of Cases among Contacts attacked in Isolation.
1st day	10	156	......
2nd "	35	170	......
3rd "	77	458	1
4th "	53	320	5
5th "	31	240	......
6th "	27	142	......
7th "	14	66	......
8th "	13	91	......
9th "	7	40	1
10th "	5	24	......
11th "	2	13	......
12th "	1	2	......
13th "	1	1	......
14th "	1	5	......
17th "	1	2	......
20th "	1	1	......
22nd "	1	......	......
46th "	1	......	......
Uncertain date	1	21	......
	282	1,752	7

This table may be read in the following way:—458 persons were exposed to risk of infection from 77 cases during the first two to three days of illness, and one was attacked after separation from them and from the houses at which they lay ill; or, 240 persons were exposed to 31 patients during the first five to six days of illness, and none of them fell ill, &c., &c.

Plague as seen at Sydney during the outbreak under notice was not "catching."

Under certain circumstances, however, plague can be communicated from the sick to the healthy; and although Table XII shows only 7 secondary cases (because seven only occurred after separation from the primary patient and from the infected premises), the fact is that 10 households altogether yielded 13 secondary cases. The circumstances under which plague is known to be communicable from the sick consist either in the form assumed by the disease, or in inoculation of diseased products of the sick body. Thus, primary plague pneumonia is very easily communicated to others (but compare the statement contained in Dr. Lorans' report on the epidemic in Mauritius, p. 17), while several of the secretions, excretions, and tissues of the diseased body carry the bacillus which is the cause of the disease. Inoculation of these products can be effected in two ways: a wound may have been made first, and the diseased matter may have been subsequently brought into contact with it; or the wound may have been made with an instrument already carrying infectious matter. This latter mode is scarcely likely to be witnessed except in the case of post-mortem examinations of the bodies of persons who have died of plague; but probably it does happen, and much more frequently than is generally supposed, when a suctorial insect first punctures the skin of a person suffering from plague, and soon afterwards punctures the skin of a healthy person. But this way can be effectual only when the blood of the plague-patient carries bacilli into the circulatory vessels of the skin; and this it does only when the patient has either suffered from the septicæmic (or blood-poisoning) form of the disease from the beginning, or else is about to die and is within 24 hours of death. The septicæmic form is seen in a minority of cases in man (in 17 out of 303 at Sydney); on the other hand, it is the commonest form of the disease in rats. It is therefore necessary to ascertain if possible, exactly how the secondary cases in the 10 households acquired their disease, before concluding that they did not get it from the primary patient.

Nine

Nine of these households yielded two cases each, one of them yielded five cases. But the secondary cases occurred under very different circumstances, according to which the 10 households will be divided into three classes: (*a*) four in which the secondary cases occurred after separation from the primary patient and the house in which he had lain ill; (*b*) three in which the secondary cases occurred before removal to isolation; and (*c*) three in which the secondary cases occurred after return of the family to the house after the latter had been cleansed and disinfected, and before release of the primary patient in two of them. The following are the requisite and available details concerning the first group:—

Case 7, m. *æt.* 2; attacked March 8th; transferred to Sydney Hospital the same day; died early on the 10th. The family of two adults and five children was removed to isolation on the 10th. On March 11th, f., *æt.* 9, and m., *æt.* 5, were attacked; on the 13th, m., *æt.* 7, and during the night of the 13th to 14th, m., *æt.* 45; form, bubonic in all. All were indigenous.

Case 15, m., *æt.* 20; attacked March 11th; notified and removed to isolation, together with 18 on the 13th. Case 18, m., *æt.* 18, was attacked March 14th. These patients were brothers who lived together; they also worked at the same warehouse; form, bubonic in both.

Case 159, f., *æt.* 24; attacked April 23rd; died May 1st before removal. Case 177, f., *æt.* 4; attacked April 29th; form, bubonic in both. The house stood on the area indicated by a cluster of dots west of the five dots representing Case 7, and the cases were indigenous to it.

Case 161, m., *æt.* 15, was attacked April 28th; removed to isolation, together with 170, May 1st. Case 170, f., *æt.* 11, was attacked May 2nd; form, both bubonic. These two patients were brother and sister; they lived on the area last-mentioned above, and the cases were indigenous to it.

Case 7 could not have infected the other four, because the patient was taken to a public hospital as soon as he was attacked and left there; and notwithstanding the plague of fleas in the cottage (see p. 25), the latter could not have derived from him any infection they may have carried, because his case was bubonic, and because he was not near death at the time he was removed from their reach. Case 15 had all those opportunities of infecting 18, which their relationship and occupation of the same dwelling imply, and the interval between the attacks was just sufficiently long for communication to have taken place, but 15 was a bubonic case, and he recovered; on the other hand, both of these patients had been occupied immediately before and down to the attack of 15 in collecting dead rats, and in destroying live ones at the warehouse at which both were employed, and which had suddenly become overrun. 177 having been closely exposed to 159 during six days of the latter's illness, and having been attacked only a little more than 24 hours before 159's death, it is possible, and even likely, that the infection was communicated from 159 to 177. 161 had opportunity of infecting 170, and in this instance no source of infection was actually discovered; but the house they occupied stood on the Redfern secondary focus, and in accordance with the views already expressed hardly requires special explanation. While the details, then, do not positively exclude communication of the infection from the primary to the secondary cases, they do not conclusively point to it either; the first two instances, indeed, strongly indicate that the infection was received from a source common to primary and secondary cases alike.

If this interpretation be correct, then among so large a total number of households it is probable that there would be some in which the primary and secondary cases were either simultaneously attacked, or were attacked successively, but at a very short interval. There were three such occurrences, of which the requisite particulars are given below.

Case 84, m., *æt.* 3; attacked April 5th; died before removal April 7th. Case 85, f., *æt.* 30; attacked April 5th; form, bubonic in both. Mother and child; lived on the original focus.

Case 101, f., *æt.* 42; attacked April 8th; removed April 12th. Case 102, f., *æt.* 32; attacked April 7th; removed April 12th; form, bubonic in both.

Case 272, f., *æt.* 13; attacked June 8th. Case 273, m., *æt.* 41; attacked June 6th; form, bubonic in both. Father and daughter; both were removed June 13th. The house is represented by two contiguous blue spots on the Botany-road.

The first pair were simultaneously attacked, the second within twenty-four hours of each other; in neither could the infection have been communicated. There must have been a common source from which both took it. In fact, 84 and 85 lived at a public-house on the infected area, close to the waters of Darling Harbour; while 101 and 102 were fellow-servants at an hotel overrun with rats, of which many had died shortly before the dates mentioned. In the third pair communication was hardly possible; it cannot have been effected by inoculation (see p. 33) from 273, whose case was bubonic and ambulant; and if not so (but still communicated in some other way), attack of 272 could scarcely have followed within, or just beyond, forty-eight hours of the attack of 273. And on the other hand, 273 was a cow-keeper, who had a large stock of fodder, in which a great number of dead rats was found by the disinfecting corps when they turned it over.

A still further test can be applied to the correctness of the interpretation put upon the facts recorded above. If, in those instances, primary and secondary cases alike owed their illness to a common source of infection, which consisted neither in infected human beings nor in infected goods, it must have inhered in some way in the premises; and, consequently, there should be instances in which the disease occurred among men who frequented premises on which no plague patient had ever lain ill, nor even had ever been while suffering. In the following Table several such instances are mentioned; the premises are places of business which were not places of residence, and which were frequented by the patients during the daytime only :—

TABLE XIII.—Showing places of business at which more than one case occurred among the workmen, and distinguishing those workmen who lived on uninfected areas.

Place of Business.	Position of Place of Business.	No. of each Case among the Workmen.	Area on which Patient lived — Infected or not.
1...	Kent-street	14	
„...	„	19	Not.
„...	„	21	
2...	„	30	Not.
„...	„	31	
„...	„	41	Not.
3...	Pitt-street	87	
„...	„	168	Not.
4...	O'Connell-street	199	Not.
„...	„	207	
„...	„	214	
5...	Haymarket	99	
„...	„	225	Not.
6...	George and Clarence Streets	106	
„...	„ „	149	
„...	„ „	171	Not.
„...	„ „	178	Not.
7...	George-street	33	Not.
„...	„	60	Not.
„...	„	69	Not.
8...	Clarence-street	36	Not.
„...	„	40	
„...	„	44	Not.
„...	„	51	
9...	Castlereagh-street	91	Not.
„...	„	92	
„...	„	96	Not.
10...	Pitt-street	164	
„...	„	189	
11...	George-street	131	
„...	„	137	
12...	„	246	
„...	„	247	Not.
13...	Castlereagh-street, Redfern	150	
„...	„ „	193	
14...	Park-street	227	Not.
„...	„	236	Not.
15...	Pitt-street	243	
„...	„	264	
16...	King-street	67	
„...	„	83	Not.
17...	Pyrmont	126	
„...	„	302	

Only 17 such places yielded multiple cases, but to a total number of 43. 10 yielded 2, 5 yielded 3, and 2 yielded 4 cases each. As will be seen from the last column of the Table, the workmen who were attacked sometimes had their homes on areas regarded as infected in accordance with the method of judgment already described; they must be excepted, therefore, as owning (in the present relation) a doubtful place of infection. But at 12 of these premises, 3 patients in a total of 3, 2 in 3, 2 in 3; 2 in 4, and 2 in 4; 2 in 2, 1 in 2, 1 in 2, 1 in 2, and 1 in 2; 1 in 3, and 1 in 3, lived on areas to which no suspicion of infectivity ever attached. It seems by far the most probable that these cases were infected on the premises at which they worked during the day; and that being so, it is on the whole likely that the remainder were infected there also, though on this it is not necessary to lay stress. The only objection which can be raised to these examples when they are relied upon to show that infection was present on premises quite apart from man is this—they all stood on the area of severe infection defined above (see par. 3, p. 27); so that these workmen ran some daily risk in crossing it, and perhaps some more definite and greater risk during the dinner hour. But, as to the former, the whole outbreak negatives liability to contract the infection by merely passing along the streets, &c.; while as to the second, it is evident that if the infection had not habitually spread on erratic courses (as judged by occurrence of cases on individual premises) an infinitely larger number of such premises should have yielded cases than actually did so, for the 17 stood precisely on that part of the city which is given up to such establishments. Yet this argument must not be incautiously pressed; for these very cases show clearly that mere presence of the infection is not enough to ensure attack. Something further, and something not commonly existent, seems necessary to enable communication of the infection from the source to man; for when buildings, which daily receive from one hundred to several hundred workpeople are judged (on the evidence just mentioned) to be seats of infection, only an exceedingly small proportion of the latter are likely to contract the disease. This has already been pointed out in another connection (see p. 29); but, indeed, the experience of ordinary houses supports the same view, since the occurrence of single cases in them was the common rule.

Even yet the evidence which points to the conclusion that the infection was erratically diffused, and which can be drawn from this epidemic, is not quite complete. Usually disinfection of premises appeared to be thoroughly effective; as a rule no cases occurred on premises which had once been evacuated, disinfected, and cleansed and which were re-occupied after five days. But in the very small minority of 3 households out of 276 further cases did occur; and this is exactly what might be expected to happen if the infection did not (as it has hitherto been expressed) inhere in the house itself, but was present in a form which allowed of its withdrawal and return.

Case 50, f., *æt.* 15; attacked March 27th, removed March 30th, together with 186. The house and contents were disinfected, and the family resumed occupation April 6th. Case 50 was released April 21th, and returned home. Case 186, m., *æt.* 5, attacked May 3rd, removed May 5th. Form, bubonic in both. The house stood on the Redfern secondary focus, not far from case 7; 186 had not been away from the house and the street in which it stood since April 6th. There was no history of rats about the house.

Case 253, m., *æt.* 6; attacked May 23rd, removed May 30th, with 288; was released June 28th; the family returned June 5th. Case 288, f., *æt.* 5, attacked June 26th; form, bubonic in both; brother and sister; lived on the Manly focus.

Case 270, m., *æt.* 5, attacked June 4th, removed June 11th, released August 24th; the family returned June 16th. Case 296, f., *æt.* 12, attacked June 26th; form, bubonic in both; brother and sister; the house stood at Surry Hills, a neighbourhood infected by extension from the Redfern focus; the cases were indigenous to it. Case 270 had found a dead rat in the kitchen two or three days before attack, and the disinfecting corps discovered several others after raising the kitchen floor.

These three instances are not cited to show that the several houses did become reinfected from the outside after they had been cleansed and disinfected; for it is quite possible that the secondary cases acquired their infection at some neighbour's house to which they may have gone. They are mentioned merely as being consistent with the supposition that the source of infection was automatically transportable, and had reintroduced itself. It can be objected that if this were the true explanation such cases should have occurred much more frequently, whereas the fact is that the disease recurred on premises after they had been cleansed only 3 times in 276; but this is conjectural, and may be met by the reply that even when the infection certainly was present it by no means followed that it would be communicated to the inhabitants.

It appears then, from the foregoing considerations, that the infection attached to neighbourhoods; that it was encountered on premises, and usually in houses; that, as judged by the occurrence of cases in man, it fell erratically on the houses in any infected district; and that even when it was known to be present on premises its communication to man was also erratic—or, at least, was effected much less commonly than might be expected in the case of this disease against which none of the population was protected. It is true that between March 12th (Case 14) and April 2nd (Case 67) 7,700 persons, and between May 11th (Case 215) and June 15th (Case 278) 2,700 more were inoculated, and that great efforts were made to restrict inoculation to those who lived on infected areas; but while this latter attempt largely failed, the total number of inoculations done in proportion to the number of persons living on or frequenting infected neighbourhoods, was far too small to account for the erratic incidence of the infection on the inhabitants or frequenters of infected premises; and, as a matter of fact, it was ascertained either not to have been received by any of the persons now referred to, or else to have been received by one here and there only. The observed behaviour of the infection, then, seems to require scrutiny with two points specially in view: the mode of its distribution in place, and the mode of its communication to man.

As to the mode of its distribution in place, it has already been remarked more than once that the only situation in which it was found (out of connection with the bodies of the sick) was in the bodies of sick and of dead rats. But that is hardly a fair statement which leaves the supposition open that it may have been present in a dozen other situations as well, but was merely not detected in them. The fact has been shown more or less fully (as regards man) that it did not exist effectively in soil, water, food, or fomites. Hence the known presence of the infection in rats points to these animals as the source from which man derived the disease. How the rats became infected is, doubtless, a question in relation to which possible infectivity of soil is of importance. But if it should be contended that the local rats received their infection thence, it must be shown first how into this virgin soil the infection came to be implanted; secondly, that having been implanted it could rest and even grow there. Now, if no case of plague in man preceded our Case 1, and if the soil became infected (if it were at all infected) otherwise than through ingress of sick rats, apparently this must have happened from communication of infection deposited on merchandise and thence transferred to the soil. Yet, while it has never been suggested that an intermediate stage of growth in soil is necessary, and while all pathological experience shows that it certainly is unnecessary (whether or not it be possible), it has been pointed out above that introduction of merchandise from infected into clean countries has never satisfactorily been shown to have communicated the infection to man, who is as susceptible to it as are rats. So it must be supposed that the infection in merchandise which did not communicate itself to rats on board ship, nor to man after it was landed, did communicate itself to rats on shore after an unnecessary, and in all probability hindering residence in soil. The merely practical consideration how the infection could probably be transferred from merchandise to soil under the usual conditions of packing, handling, and warehousing, need only be mentioned. It is manifestly most likely that the infection, if communicated to the soil at all, was so communicated by sick rats landed from a ship; but then, why should the soil-stage be imagined? Plague spreads from rat to rat in part, at all events, and with certainty, by the healthy feeding on the bodies of the dead. This is the way in which Loeffler's mouse-typhoid, and the disease of rats caused by Danysz' organism are spread, and in those cases is, perhaps, the only way—both being diseases caused by organisms which belong to the same group as *B. Pestis.* In short, the introduction of sick rats would seem to be an adequate and highly probable cause of the direct infection of local rats, while suggestion of the soil as a link seems unnecessary, and besides almost entirely lacks the requisite basis in observed facts.

The question whether Case 1 were the first case which occurred has little importance in relation to the epidemic (because this was not due either to direct or mediate infection from the sick), but may have some in relation to the epizoötic. Exceptionally in our experience, though certainly if suitable measures are employed, the infection is communicable from man to man by mediate means, and therefore may be communicated from man to rat: the following is the only instance which we met with, and it concerns man alone.

Case 262, m., *æt.* 22, engaged March 8th as scavenger at the Maritime Quarantine Station.

May 30th, at 6·30 p.m., went to lie down as usual before beginning his night duty, and afterwards had shivering, nausea, and headache; slept.

May 31st.—Awoke feeling well, but had slight diarrhœa; continued well all day; in the evening headache came on again; it lasted an hour only. Did his work during the night.

June 1st.—Was thirsty all day; went to his work at night.

June 2nd.—Was obliged to give up work at 4·30 a.m. Reported himself sick at 11·30 a.m.; was admitted to hospital at 2 p.m. On examination, temperature 98°·8, face flushed, eyes suffused, but not markedly; pulse slightly quickened, and of normal tension. A swollen gland the size of a large almond, and very tender, in right axilla; less enlargement of three or four cervical glands behind the sterno-cleido-mastoid muscle, which were not tender. 40/c/c. Yersin-Roux serum subcutaneously.

June 28.—Returned to duty.

The progress of the case calls for no special remark. The patient began to recover soon after admission. Liquid was withdrawn from the axillary gland (probably on June 5th) and microscopically examined on June 7th, with a negative result as regards *B. Pestis*, but streptococci were present. None of the enlarged glands suppurated. In the opinion of three experienced medical men who examined the case on or shortly after admission, there was no doubt the illness was plague.

On May 22nd the patient had received at the gate of the hospital enclosure the coffined bodies of two plague patients. These bodies had, as usual, been wrapped in a sheet wet with sublimate solution, and placed in a coffin having water-tight joints, by wardsmen; the coffins were then screwed down, wrapped in a cloth wet with sublimate solution, and handed to the patient, who helped the sexton to wheel them to the burying-ground. His other duties consisted in scavenging refuse and night-soil from all parts of the Station, except the hospital enclosure, but including the convalescent quarters; this he did during the night, and he never came into personal contact with the convalescent patients. He had on his right hand six grazes which were scabbed over, and which seemed not to have healed as quickly as such slight injuries should; he had also several horizontal cracks in the skin of the right fore-finger.

On the whole, the above account cannot be accepted as proof of mediate infection (inoculation of infectious material, perhaps from dressings discarded by convalescents); but the case was diagnosed as plague by gentlemen who at that date had had very considerable experience, and apparently inoculation could have come about only in some such way.

At this date, then—namely, more than nine months after the recognition of Case 1—it is still the general opinion that no other case in man preceded it. A comparison of the rates of death under causes in corresponding months of previous years disclosed rather smaller rates than usual. A stronger argument (because there is no reason whatever for suspecting that unobserved plague caused such fatality as would impress the returns with unusual features) can be deduced from the general proficiency and public spirit of the medical profession of Sydney; from the population being either of immediate European descent, or at the older ages actually of European birth in considerable proportion, and almost entirely British; from the ease with which medical advice can be obtained, and the universal habit of seeking it on occasion; from the number of friendly or provident societies; from the number, size, and accessibility of the public hospitals, as well as of other institutions where gratuitous medical advice is either available or whence applicants are directed to other places where it is furnished. Under these circumstances the presence of plague in New Caledonia became known, and placed the medical profession on its guard a month before Case 1 occurred (and effectually, as the instant report of Case 1 itself shows); while after the published identification of that case a whole month elapsed before the occurrence of Case 2, though in the interval suspected cases were referred for diagnosis. It is, nevertheless, possible, of course, that one or more unrecognised cases did occur; but to assume this seems as unnecessary as does the assumption that the epizoötic sprang, not directly from infected rats, but in a roundabout way from some unidentified source through the soil. At the same time, the possibility that the epizoötic arose from communication of the infection to rats (perhaps in sewers) through the infected excreta of an unknown case in man cannot be excluded, for no demonstration is or can be possible. It is perfectly clear, however, that Case 1 followed, and did not precede, the epizoötic; while reason has been shown for asserting that Case 1 actually did receive his infection from a rat. That reason will appear the stronger to those who are well acquainted with the investigations of Dr. P. L. G. Simond, *Médicin Principal des Colonies Françaises*, and who have observed that they explain and bring into accord many apparently dissociated or even opposed facts recorded of plague.

Admitting, then, that the source of infection for the local rats cannot be demonstrated to have been infected foreign rats, but asserting on ætiological and general grounds that this origin is almost infinitely probable, it must be enquired whether the observed distribution of plague rats in Sydney was sufficiently wide to account for the epidemic. It has been subsumed throughout the foregoing pages that man was usually infected by rats; whether it actually were so or not, was it possible?

On diagram B certain dates are inserted in red ink, some of which are underlined. They indicate some of the neighbourhoods in which diseased or dead rats were discovered. The under-score means that plague was demonstrated in the rats indicated by microscopical, cultural, and inoculation tests conducted in the laboratories. Where there is no under-score the note means that dead rats in numbers had been seen by some member of the staff, under circumstances which denoted death by disease, not by poison; very often (in 70 infected houses) the report was received from the disinfecting corps by which the bodies had been (and often had first been) discovered. It was rather commonly the case that the members of infected households had nothing to report concerning presence of rats alive or dead on the premises where these animals and their bodies were found on proper search. In one case (Queen-street, Woollahra) the infected animal was a cat; it was forwarded by Dr. W. H. Quaife, and was the only one of 5 received at the laboratory which had plague. No case of illness occurred in the house whence it came, which stood, however, on an infected area. Of 6 house-mice received, 2 had plague. The total number of rats examined at the laboratories was 167, of which 50 were alive; 10 of these were sick, and 4 of the sick rats had plague; of the 117 dead rats, many of which were putrid, 19 were shown to have had plague (see Appendix A, p. 53). The infected animals came from widely-separated localities within the city of Sydney where 41·5 per cent. of the total cases occurred; and two of them from the distant suburbs, Manly and Woollahra. These 23 are all the instances in which plague was rigidly demonstrated in animals; but very many rats were examined which there was no reason to doubt had also died of plague.

The above is the recorded evidence that rats over a considerable area of Sydney, which was the area on which cases of plague in man occurred, suffered from an epizoötic; and that this epizoötic (which began before plague in man occurred, and ceased, as far as can be learnt, about the same time as the epidemic ceased) was plague. In practice, however, many reports of dead rats, and of the sudden invasion of premises by rats where none had been before, which were commonly made during continuance of the epidemic were taken as supplementing the evidence already given; and it would be erroneous to suppose that the recorded and rigidly proved instances were the only ones which were credible. This was far from being the case; and if it be desirable that many more well-established observations should have been recorded—as, undoubtedly, it is—it is also the case that our resources were not adequate to furnish a separate staff to watch over the epidemiological features of this outbreak. What was possible was done.

In short, that the infection was disseminated by rats appears tolerably certain, and it may not be too much to surmise that plague is primarily a disease of the rat which is communicable to some other animals, among which man happens to be included. The real difficulty is encountered when an explanation of the way in which it was communicated from rats to man is sought. It must be remembered that the prevalent opinion now is that, generally speaking, man contracts plague by inoculation. A rat might well disseminate the infection on the air by sneezing, since it is found on the nasal mucous membrane of rats; but this, perhaps, would produce the primary pneumonic form in man—not a common form in any epidemic, and, with a single doubtful exception, not seen during the Sydney epidemic. A rat might also disseminate it with its excreta; but, if this should suffice to bring it within striking distance of man sufficiently often to cause epidemic prevalence of a practically non-infectious disease (in the common bubonic and the less common septicæmic forms), it must operate usually by contamination of food or of articles other than food. As to food man rarely (if ever), as a matter of fact, gets the disease by ingestion. Many an article might be soiled with the infection without causing inoculation or, rather, few articles so soiled are capable of inflicting a wound, and still less often are likely to enter into the circumstances which would afford the necessary opportunity; but there is certainly one exception. If hay became the medium for deposited infection any person handling it would be very likely to receive the slight wound which alone is necessary to inoculation; but hay is just as likely to carry the rats themselves, dead or alive. After all, however, this accident could not occur often enough to be of importance in causation of an epidemic, and the opportunity is taken to mention it merely because it affords a possible explanation of Cases 4 and 272-3 as well, perhaps, as of some others of those which are classed in Table X as employed at produce stores. But case 273, p. 35, hints another and simpler interpretation.

The means of inoculation must be one commonly in operation in order to be an efficient cause of epidemics. Hence the observed preponderance of bubonic enlargement of the glands of the groin, which indicates entry of the infection at some part of the lower extremity, and which has been observed in the barefooted populations of the East, is often ascribed to the wounds which unprotected feet receive. It may even be surmised that the notion of spread of the infection mediately through the soil has received some unacknowledged support from this theory. But the facts do not at all warrant it. The preponderance of groin buboes at Sydney was as striking as in any other part of the world. Among the total 303 cases there were 17 which had no bubo; in the remaining 286 cases the bubo occupied the right inguino-femoral region in 99, the left in 101, and it was bilateral in 9; making altogether 209 in which the bubo occurred in the inguino-femoral region and no where else, or 73 per cent. of all those which showed buboes at all. Yet the inhabitants of Sydney, and those among them who were attacked, no more go barefoot than do the inhabitants of London. They live in a sub-tropical climate, but their habits in all matters of dress are still entirely those of the people of northern Europe.

Needless, however, to beat about the bush. Granting that plague in man is usually the result of inoculation, the manner in which this can be brought about on a sufficient scale to account for an epidemic would remain hidden but for the observations of Dr. P. L. G. Simond, already referred to. A sufficient account of the leading points in his teaching appears in Appendix A, p. 56, and need not be repeated here; but to appreciate the weight of his observations his original paper must of course be studied. He considers that plague is most often communicated to man by fleas which, after feeding on plague rats, become transferred to man whom they inoculate. Thus also, he thinks, is the disease sometimes conveyed from rat to rat and to other susceptible animals. The minute puncture usually leaves no mark, but in a small proportion of cases it produces a phlyctenule or a bleb. Such a lesion was observed in seven of our cases; excepting Case 1 it appeared as a small papule, surmounted with a minute vesicle; from two of these in two different cases smears were made; in one of the smears bacilli morphologically resembling *B. Pestis* were demonstrated. It is not to be supposed that all our cases were searched with this object in view; many were, and the six formed but a small proportion of the total examined, but a quite systematic and quite thorough search could not be carried out in all cases. Several fleas taken from infected rats were examined; in one a bacillus resembling *B. Pestis* was demonstrated, and it was identified by the result of inoculation into a guinea-pig.

Nine fleas taken from rats received at the laboratories were referred to the Government Entomologist (Mr. Walter. W. Froggatt) for classification. Mr. Froggatt reported upon them as follows:—

> Slide No. 2 Dog-flea (*Pulex Serraticeps, Germ*). This is our common cat and dog flea, and has been described under the name *P. Canis* and *P. Felis.* These specimens do not exactly agree with my typical form (which was caught in the office), as the teeth-like spines on the lower edge of the head are absent, but this may be a variation in the sexes. The dog flea is the common house-flea in the United States, *P. Irritans* being a rare species with them, and seldom found. "Examination of many specimens of fleas sent to the Department in recent years shows that the species which commonly overruns houses during damp summers in our eastern cities at least, is not, as many have supposed, the human flea, but the common cosmopolitan flea of the dog and cat." (L. O. Howard, in Bulletin No. 4, division of Entomology, U.S. Department of Agriculture, 1896, p. 24).
>
> Slide No. 3. This slide contains 3 specimens; one, the largest, is another specimen of *P. Serraticeps;* the 2 small ones are rat-fleas (*P. Fasciatus, Bosc.*)
>
> Slide No. 4. Rat-flea (*P. Fasciatus, Bosc.*) Slide No. 5. Three specimens of the same.

P. Fasciatus was of the most usual brown colour. *P. Serraticeps* is said by Neumann not to bite man; but this is not in accord with general experience, and would seem from the reference furnished by Mr. Froggatt not to be the case in the United States. Whether *P. Fasciatus* will bite man is not known here; no experiments to test this point were tried during the epidemic. As Dr. Frank Tidswell has suggested, it is likely enough that varieties which will not, or do not, commonly infest houses and man, may yet bite once when they find themselves on the human body. *P. Serraticeps*, however, which certainly does bite man, was found on two of the small number of rats thus examined.

The teaching of the foregoing study of plague as it appeared at Sydney, seems to be as follows:—

1. The disease was not directly communicated from the sick to the well—in other words was not "catching."

2. It was not communicated in any important degree, at all events, from the sick to the well by mediate channels (clothes, household goods, merchandise, excreta).

3. The infection attached to localities, and spread to others adjoining and continuous with that in which it was first manifested.

4. It also spread in a fashion which betokens the possibility of its being transported mechanically from an existent focus to a considerable distance (Moore Park garbage-tip and Manly), and there initiating an independent focus.

5. In the buildings on any infected locality cases occurred irregularly, and showed no special proneness to occur in adjoining houses.

6. When the occurrence of one case among the inhabitants of a building showed that the infection was present in it, secondary cases rarely followed. Irregularity of incidence on houses was accompanied with irregularity of incidence on the inmates.

7. An epizoötic disease among rats preceded the first case which occurred in man.

8. This epizoötic disease was plague.

9. The area over which the epizoötic extended was practically co-extensive with that on which cases of plague in man were observed.

10. The epizoötic died out as far as can be learned at the same time as the epidemic ceased.

11. The epidemic was caused by communication of the infection from rats to man.

VII.—Prevention.

It will appear ultimately that the best protection against epidemic plague lies in sufficient sanitary laws, persistently and faithfully executed by Local Authorities during absence of the disease, and that no other general scheme of defence is practicable.

Successful prevention of epidemic diseases depends entirely on knowledge of their nature, of their causes, and of the means by which the latter are diffused. On these points our experience has shed useful light, though many details remain to be worked out—some in the laboratory, some in the field; while others still require, and now urgently demand, assistance from those who profess correlated branches of science. In such circumstances practical management of a present epidemic cannot proceed unless certain assumptions are made; and it is worth while to point out here that rational assumptions which coördinate and explain accurately observed facts have nothing in common with guesses. Accordingly, the following remarks are made in view of the facts and inferences recorded above, and with reference to epidemic plague in the bubonic form.

The prevention of epidemic plague might be discussed under the three heads importation, local diffusion, and exportation. Under importation fall international notification, arrest of infected persons and things, and destruction of rats afloat. Under local diffusion fall care of the sick, care of contacts, protective inoculation, exclusion of rats from dwellings and the immediate neighbourhood of man, destruction of rats, destruction of human parasites, cleansing and disinfection. Under exportation fall the steps which can practically be taken with hope of preventing diffusion of the disease from infected spots (*a*) to clean places within the same country, and (*b*) to clean places beyond its borders. It will not be convenient to take these subjects exactly in the above order. It will be best to inquire first who may properly be designated "contacts," and how these persons should be treated.

The term is much in use; it has a certain convenience, but unfortunately no defined meaning. Probably it was devised to indicate those who had recently been in close association with the sick; and were it so employed in connection with smallpox, for instance (which is maintained and diffused exclusively by communication of the infection from the sick to the healthy), it would be not merely useful, but sufficiently exact. But in the present connection it is inaccurate. As we have now learned, bubonic plague and smallpox do not become epidemic by the same means; our epidemic was not caused or maintained by communication of the infection from the sick to healthy human beings, either mediately or directly. As long, then, as the word "contact" is used with reference to preventive measures, of which one is obviously indicated by it, it does not necessarily apply to those who have been recently associated with persons who are actually suffering from plague. On the other hand, our experience has shown that infectiveness attaches to localities; so that "contact" might properly be used to designate a person who had lived on, or who had been exposed to the influence of, an infective locality; and he would deserve this distinctive epithet for five days after he had been completely separated from that place, because the infection (if it has been taken) reveals itself within that period in occurrence of the disease. But our experience has further taught that local infectivity is not due to any inherent peculiarity (attaching, for example, to the soil), but merely to the casual presence of plague-rats. So a "contact" is one who has been more or less closely associated with plague-rats.

The other persons living in any house which contains a plague-stricken human being, then, may or may not be "contacts." The presence of the patient is evidence merely that he has at some time been a "contact" himself within the meaning of the definition, but it predicates nothing of the rest of the household. Effective exposure to the infection (inoculation) must necessarily be little more than momentary; so that no person who moved about up to the time of his attack can be assumed to have received the infection either at that place where he lives and is found or at those other places which he frequented. In point of fact it has been shown that the place of infection was sometimes not the dwelling, but the workshop; and, on the other hand, that it was sometimes not the workshop, but precisely the place of residence. In short, the first hint that infection is somewhere to be encountered usually consists in occurrence of the disease; and this only furnishes occasion for inquiring where it was encountered. The search will naturally begin with the patient's immediate surroundings, but often these furnish no clue; it must be continued to distant places frequented by him, and there the source may be found.

It is plain, therefore, that no general rule according to which all those who are found in contact with a plague patient shall be dealt with can be laid down, and that the attempt to enforce such a rule will not only lead to injustice in a majority of the cases submitted to it, but must unnecessarily embarrass the central health authority; more than that, it would be found practically impossible to adhere to it in the case of many business establishments, such as banks, public Departments, and the like. Each case must be treated according to the known facts of the place or places concerned, and the general features of the epidemic. What these are is always much better known to the central health authority than to any other party, for it has (and, if it be properly organised, it alone can have) possession of the information on which a prudent judgment can be based; it is, additionally, the most competent interpreter of the facts within its knowledge. The central health authority will be most wisely left absolutely free to take such measures to control the epidemic as to it seem best; much more, therefore, should it be left absolutely free to deal as it thinks most prudent with individual premises and the persons associated with the patient. It is also obviously necessary that its decisions be accepted as final and unquestionable. Every other course must result in increase of public agitation, in unnecessary expenditure, and in great risk of prolonging the visitation.

Secondly, it is convenient to inquire how the sick themselves should be dealt with. It has now been said many times that the epidemic was not maintained either by direct or mediate communication of the infection from man, and it has doubtless seemed—and very naturally seemed—that no better reason for leaving the sick where they are found could be given. But true though the statement be, this inference would be false. Plague is a disease common to man and to rats; whether it be primarily a disease of rats or not is of little immediate importance.

It can be communicated from rats to men, and from men to rats by suitable means—the word "suitable" in this connection meaning "by inoculation," though as regards rats only it includes also feeding on plague-rats. Those are the facts of such communication experimentally ascertained; it is probable also, but not ascertained, that the disease can be communicated from man to rat in other ways—namely, through the infective matters cast off from the diseased human body. Indian records are not devoid of instances which suggest that this may occasionally have been the true sequence of events in a few localities; and therefore, although they scarcely amount to proof, and although (it is believed) communication of the disease to rats by such means has not been demonstrated to be an experimental possibility, yet there is ample reason for collecting everything which proceeds from the infected human body and for destroying it, or at least for rendering it non-infectious by one or other of those means which are known to be efficacious. Now, a central health authority, charged with the heavy responsibilities which attach to management of an epidemic of plague, would be imprudent which left the precautions just mentioned to be taken by the members of individual households, whatever their resources might be. All of the sick should be removed at the earliest possible moment to an isolation hospital strictly managed under immediate direction of the central health authority; but cases occur in which no isolation hospital exists within reach, and some others in which ample means and the isolated situation of the houses in which they occur render it not absolutely necessary to remove the patient. In all such cases the central health authority may leave him at home, but only on condition that he is nursed by nurses in its employment and under direction (in all matters relating to prevention of spread of the infection) of a member of its own medical staff. On the whole, though extreme care is in every case necessary, greater care, if possible, would appear to be requisite with houses connected to a sewerage system than with others.

Thus, for the present at all events, every actual case of plague must be regarded as a danger to the whole community; and therefore, in connection with the question whether the sick must be isolated, attention should be drawn to the fact that plague is communicable from man to man both by direct and mediate channels, although our epidemic was not maintained by such communication. Primary plague pneumonia is directly communicable to man; and further, whatever the form of plague may be in which a case of the disease begins, secondary plague pneumonia is liable to supervene. The patient's expectorations then carry the bacillus, and therefore are probably dangerous. Additionally, the excreta, both solid and liquid, sometimes (with unascertained frequency) also carry the bacillus; this happens at all events when the minute hæmorrhages into the submucous coats escape into hollow organs, and possibly under other circumstances; while the discharge from bubonic abscesses always carries the bacillus in profusion at first, and on very good authority is said to continue to carry it in viable (though not necessarily in virulent) form for many days. Lastly, in almost all septicæmic cases, and in many others of whatever form when death impends, bacilli are easily found in profusion in the general blood-stream, even in the capillary vessels of the skin, and from the latter the infection can be abstracted by suctorial insects (fleas and bugs), and may be inoculated by them into the healthy, or into rats. So that for the sake of preventing as much as possible occasional communication of the disease from the sick to others associated with them, and largely for the sake of diminishing the risk of infection of rats from cases in human beings, and of rendering control of those risks more easy and certain, all plague-cases in man must be isolated under immediate direction of the central health authority; and in the vast majority of cases it will be not only expedient, but necessary, to effect this by transfer to hospital. In view of the rare exceptions which will be met with, the central health authority must be left absolutely free to decide what shall be done in each case on its merits, and, again, its decisions must be accepted as final, and must be unquestionable. The fears and fancies which preoccupy the mind of the general public on such occasions, and the dicta of those among them who rely for guidance on common sense, cause confusion, sap confidence, favour panic, and pave the way for disaster.

International notification of plague has its uses, although the information thus communicated comes too late to set in motion those preventive measures which would prevent importation—if they ever could be thoroughly effectual. It is not customary to notify the presence of plague unless there is good reason to consider it epidemic. But, which is of more importance, the notification regards exclusively manifestation of the disease in man. This, we have learned, is a matter of secondary importance. It has been preceded by the epizoötic; and the real danger to the importing country lies with plague-rats, not with plague-stricken men. Evidently notification, as at present understood and practised, cannot much help in preventing importation of plague.

It is hardly possible to conceive how a measure taken to prevent the risk of importing plague-rats could be made dependent on notification of disease among rats at the port of departure; besides which the defences of that country which relies on other countries for aid in raising them are likely to be inefficient. Were the fullest information always available in time, which it never could be, the object would be to kill all the rats—not a majority, but all of them must be destroyed—on every incoming vessel; and this could be done in practice only by landing cargo on a small island, overhauling it, treating the hull, and reloading the vessel before allowing it to approach the quays. But there can be little doubt that this is impracticable. It is possible to kill many rats on laden vessels; though at the best it must always remain doubtful whether all have been killed, and a difficulty arises in connection with damage to cargo. Experience has led us to rely on sulphur fumes.

Rats will not venture where there is the least smell of sulphur dioxide, and they are easily killed by respiring air which contains a moderate proportion of it. The practical use which has been made of these facts, is the following:—Small quantities of sulphur are burned on upper decks, &c., being only enough to taint the air rather strongly; this not merely causes rats to retire to the lower parts, but seems sufficient to prevent them from returning even when the next stage of the process is in full swing. This consists in closing holds, bunkers, &c., &c., by the usual means, and in then burning sulphur in the estimated proportion of about 2 lb. to every 1,000 cubic feet of unoccupied space. The exposure should last not less than six hours. This plan is effectual, though there is reason to think it is not always completely so. It is easily managed, and the only objection to it is damage to some kinds of cargo by taint of sulphurous acid. It has already been mentioned that as many as 287 dead rats were gathered from a small steamer after fumigating it in the above-mentioned manner; and at Newcastle where vessels generally arrive in ballast to load coal, or else carrying a moderate load (say up to 1,000 tons) of general cargo for the most part cased, the number thus destroyed has varied from a few to a "tubful". As a matter of fact, no serious complaint of damage to cargo has been made; but vessels from New Caledonia ceased to bring coffee during continuance of these precautions which, it was thought, would be unmerchantable after fumigation with sulphur. The alternatives to sulphur appear to be formaldehyde and carbon dioxide, both of which were suggested at an early date. As to the former, its practical use requires more careful management than available fumigators can be relied upon for; errors and omissions can seldom be made good by a second operation, for although shipowners submit willingly enough to a detention of known duration, they expect the time to be utilised in a businesslike way. Formaldehyde is, moreover, expensive. Carbon dioxide appears a more promising agent, but it has serious drawbacks. In the first place it does not favour collection of living rats in holds and bilges where alone this gas would in all probability collect in sufficient proportions to kill, and if perceived by the rats it would be easily evaded by them. As to disengaging it in the required quantity and with the requisite promptitude, this could only be effected with cylinders of the compressed gas; but those who have used them are aware of the practical difficulties which are encountered. The gas might be disengaged from chalk and muriatic acid; but it happens that the Department has had some practical experience of this method in connection with the killing of stray dogs by the police, and the result of the experiments conducted by the Government Analyst (Mr. W. M. Hamlet, F.I.C., F.C.S.) precluded all thought of attempting to employ this plan on shipboard. On the whole, our experience has shown us that sulphur dioxide is the only agent practically useful for the present purpose, notwithstanding some drawbacks.

But we have learned more than this, which leaves the cargo difficulty (in practice not important with us) untouched. It would be much better not to have rats on board ship, than to attempt to kill them off on laden vessels; and there is not much difficulty in keeping them away. The method is to fumigate the vessels with sulphur while empty, or nearly empty, at the beginning and end of voyages. According to the reports furnished by the Superintendent of Fumigation (Captain G. Tait) it appears that if vessels which engage in coasting voyages lasting about three weeks, or from that to a month, are fumigated at the port of departure before loading, and at the ultimate port touched on the voyage (when they usually have some cargo on board), few and often no rats are discovered after the next fumigation done on return to the port of departure before commencing a fresh voyage. This statement applies to steam-vessels of various tonnages up to about 4,000. The method has been practically carried out under intercolonial agreement, which requires that such vessels shall produce a certificate of fumigation while empty at the port of departure, and at the ultimate port of the voyage, without which they are not allowed to communicate with the shore except after a prohibitory detention at quarantine.

In conjunction with this precaution, which might well be adopted under an international agreement, others, designed to prevent intercommunication between shore and ship rats while lying at quays, should be adopted. These consist essentially in the use of shields on springs and hawsers, in fending off vessels from quays, or in hauling off at nightfall, in closing openings in the sides, and in hauling up gangways at night unless in actual use, in illuminating the quay and the ship's side, and in providing watchmen.

Lastly, quays must be properly constructed—that is to say, they must terminate in a solid sea-wall of masonry or concrete at a point below low-water mark, so that wharves built out always have water beneath them. The wharves at Darling Harbour, which were the starting-point of the epidemic, are very old, and everything which wharves should not be. They consist of staging carried out over the foreshores, the quay wall being sometimes barely within reach of high water, and constructed either of seriously defective rubblework, or else of sheet-piling in bad order and filled in behind with large stones. Both afford ample harbour for rats, which were found to exist there in great numbers, while the mudbanks which are exposed at low tide and the piles which support the wharf-deckings collected and retained the dead animals and heaps of organic wastes, which insufficient scavenging and defective supervision caused to be thrown into the water. These faults will now be remedied in course of time under the Darling Harbour Resumption Act, and the Harbour Trust established by it, and this part of Darling Harbour will be reconstructed to resemble other parts which are already built in the manner recommended above.

While very much can be done to impede entry of plague-rats by the means described, which, therefore, should be adopted and steadily used, it is evidently unlikely that they can prevent such entry, or, in other words, be at all times completely effectual. Failure in connection with a single vessel, even though partial only, the entry of a single plague-rat to the rat community ashore is all that is necessary to originate an epizoötic of plague: and this is likely to occur, first, because all the described precautions can hardly be continuously taken; secondly, because information of the occasion for taking them is usually received after the risk has been run; and, thirdly, because of the unavoidable uncertainty of their effect when they have been taken. We pass on, then, to consider what should be done to control a present epidemic, and what should be done ashore to render recurrence of it as difficult as possible.

During an epidemic the only proceeding of much value is destruction of rats and of their nests, burrows, and habitual haunts, and those others which are calculated to prevent access of surviving rats to proximity with human beings—in other words, to expel them from occupied premises, and to keep them outside. This measure was given a first place in the precautions recommended to householders in the pamphlet issued from the Department on March 1st (Appendix II, p. 75), and, on the whole, subsequent experience may be said to have established its usefulness. It is true, no doubt, that several people were infected at wharves, and four others in the course of scavenging infected areas (though whether within or outside dwellings does not appear) but the great majority were infected on premises. On premises where indigenous cases had occurred, moreover, the presence of freshly-deceased rats was discovered quite often enough to support the general proposition that the danger of contracting plague stood in relation to the presence of rats in dwellings or enclosed premises. A general slaughter of rats would answer the purpose, if it could be carried out quickly, and with tolerable completeness; but that is practically impossible.

Slaughter of rats was attempted by us, and doubtless should always be attempted. The following steps were taken:—The City Council, within whose district the epidemic commenced and fell most heavily, early instituted a special rat-catching staff, and ultimately reported that it had destroyed 38,600; the business was then taken over by the Government. A considerable staff of rat-catchers was employed, who worked according to indications furnished by the Department, or else from observation; a capitation fee of 2d., subsequently raised as already described to 6d., was paid for the body of every rat brought in by the public; depôts at which rats were received, paid for and burned, were established at various points in the suburbs; municipal councils were gratuitously supplied with rat-poison for distribution among their ratepayers, and with a man to distribute it, and to exhort the people to lay it; the Board of Water Supply and Sewerage, fumigated the sewers with sulphur in a systematic way; officers in charge of public buildings were instructed to take similar measures; and many private firms, including owners of wharves and steamships, as well as private householders, dealt with their own property. There was delay in commencing the destruction of rats on a scale likely to be at all useful. It was only seriously attempted after the public attention had been aroused by a last appeal made by the Department on April 9th, when the 96th case had already occurred. It is difficult to estimate the effect on the rat population which was produced. The total recorded number of rats killed by the Government staff between April 18th and

October 31st was, in the city, 56,136; in the suburbs, 13,572; total, 69,708. To this must be added the number claimed to have been killed by the local authority for the city, namely, 38,600, making a recorded grand total of 108,308. Private persons probably killed a considerable additional number; and many were killed by the scavenging staff in the course of its operations.

On April 3rd the Water and Sewerage Board commenced fumigating the sewers. Within the city of Sydney, though many intercepting sewers have been constructed by the Board which are in all respects in good order, the greater part of the district is still served by very old and ill-constructed sewers; and the house-connections are, in the case of about 20–21,000 houses out of 22,000, improper, imperfect, and dangerous. Outside the city all sewers have been constructed by the Board; these in themselves and in their connections are what they should be. In the first place, then, the general statement may be made that probably very few rats existed in the new sewers, but great numbers in the old ones. While the new sewers afford them no lodgement, the outfalls discharge either into deep water or on well-tended filtration areas or sewage farms; while the old city sewers are too often accessible from harbour foreshores. The method adopted was either to blow the fumes of sulphur into them, or to burn sulphur in trays suspended beneath manholes; afterwards they were flushed with water to wash down the dead rats. The result, gathered from the reports regularly issued by the Board, cannot be expressed in numbers. From the new sewers very few carcases were got; from the old sewers large numbers were washed down (at all events at commencement of these operations), and it is believed that many must have been killed which never were seen. As a matter of fact only between 300 and 400 were actually gathered by the workmen employed, but, as just mentioned, this does not bear any definite relation to the numbers actually killed and seen, though not collected. In the city an incidental and useful effect of the fumigation was to fix the position of many faults in the old system, through which the fumes escaped so as to be strongly perceived within houses, and even in the open.

Employment of the organism used by Professor Loeffler to destroy mice had at an early date been recommended in letters to the daily papers for the destruction of rats. The Department, however, had investigated this matter at great length two years earlier in relation to its proposed use for destroying flying-foxes (see Annual Report of the Board of Health for the year 1898), and had subsequently extended the inquiry to ascertain its powers and usefulness for the destruction of rats both in the laboratory and in the field. The results showed that while the scattering of bait impregnated with broth cultures of Loeffler's *B. Typhi Murium* often resulted in disappearance of rats from their old haunts, very few sick rats were ever seen and no dead bodies were ever found; while in one locality unmistakable evidence was got that the infection of a few animals was immediately followed by retirement of the whole horde to some neighbouring spot not far distant, where it lived in good health.

Cultures of Danysz' organism, recommended by the discoverer for destruction of both rats and mice, had been cabled for at beginning of the year, in consequence of an account of its apparent effects which had been communicated to the President by a *confrére* in New Caledonia. As soon as they arrived (May 3rd) this organism also was examined in the laboratory and tested in the field, without any useful result being attained. At a later date Danysz' own account of the organism was published, from which it appeared that the disease caused by it spread only to rats which fed on the bodies of rats killed by eating the original bait, and that it was not alleged to cause a disease freely communicable in other ways, such as seems to be requisite to its effectiveness in the desired direction.

Nevertheless, it is likely enough that an impression was produced on rats in certain districts, and in as far as such districts were infected that impression was useful. It can have been useful, however, only to the inhabitants; for rats flee as soon as they are persistently disturbed, and partly (only) for this reason the infected rats spread beyond that area on which the epizoötic first appeared. This danger was recognised by the public, which desired that before attempts at destroying rats in an infected district were made the locality should be surrounded by a fence to prevent their dispersion. This, as well as many another suggestion of a different kind, was made at a comparatively late stage of the epidemic—at a time, at all events, when alarm had rendered it possible to secure public approval for almost any proceeding, however inconvenient, expensive, or oppressive it might be; and it is necessary to point this out because, even at the date when it might have been tried, it would no longer have been useful. Without discussing the question whether any fence which could be erected in a large city would have the desired effect, the fact was that before they were disturbed by efforts made to destroy them, infected rats had spread far beyond any such restricted area as could be fenced. This had happened in accordance with the instinct which causes rats to desert places where disease attacks them, or where poison is effectually laid for them. Case 7 (March 8th), it has been shown above, was infected where the patient was found, at a distance of about 2 miles from Darling Harbour; while the occurence of Case 15 showed that plague-rats had already invaded premises as far away from the shore line as York-street by March 13th. Other instances could be mentioned; but, in short, while it was sufficiently difficult to watch the progress of the epidemic in man, it was quite impossible to observe extension of the disease among rats. The conclusion as to rat-fencing is that it is one of those measures which would be useful if only they were practicable, while the conclusion as to rat-killing is that it may be useful and should be persevered with, but that it can never be more than an assistant means, and never can be a preventive. A better defence must be looked for in other directions.

What this is has already been mentioned. Importation of plague-rats may be impeded if good fortune accompany care, but in the long run it cannot be prevented. Rats ashore may be killed in large numbers, but it is hardly possible to suppose that they might be exterminated; besides, the epizoötic will usually have made considerable headway before the disease has been communicated to man, and, therefore, before it has been noticed. In the meantime, the rats will have scattered widely, not in consequence of attempts to destroy them, but of their own motion, and in accordance with those habits which are commonly known to cause them to leave any place where they find their companions dying. Under these apparently hopeless circumstances, examination of the facts of the late epidemic show that the infection was practically always taken on premises. This was only learned from careful observation, record, and consideration of all the facts of the outbreak; but, having been pointed out, the deduction from it is obvious. It is that the important practical protection against epidemic plague consists in removal of all those conditions which favour the harbourage, feeding, and breeding of rats in the immediate neighbourhood of occupied premises, and in excluding rats from dwellings.

This mode of defence is no sooner mentioned than it is seen to be practicable; and not merely so, but to be attainable by the steady and faithful execution of the elementary details of municipal sanitation. The places in which rats live and breed are the dark and intricate recesses which exist about ill-constructed or decaying structures; heaps of household refuse, which afford warmth, and in which they burrow; ill-made basements, cellars, and store-rooms, where defective flooring is supported above the natural soil; stables and dungheaps. The conditions which attract and retain them are the presence or near neighbourhood of food; if (as is usually the case) they are to be met with in hardware and soft goods stores which have been ill-constructed or which have fallen into disrepair, they are more constantly found in butchers' shops, produce stores, grocers' shops, public houses, hotels, and kitchens; and are always to be seen at night in lanes and rights-of-way, however well paved these may be, hunting for food in garbage boxes or dustholes. Access to buildings and to dwellings from the outside is furnished to them sometimes by defects of structure which may even be such as in every other relation are unimportant; at others through doors left open at night; but largely through the more serious gaps which occur in the course of decay of dwellings in which, also, there are sure to be many nooks in which they can permanently establish themselves. And, again, they are attracted to the neighbourhood of such dwellings especially by the lumber and organic refuse which too often are allowed by local authorities to accumulate in back yards and on waste land, and which furnish food and cover for them. The conditions adverted to are often accompanied by permanent infestation of premises with parasitical insects, among which fleas and bugs are of most importance in the present connection; for dirt, decay, darkness, and filth favour them at least as much as they favour the presence of rats. Lastly, as with other matters which fall under the general heading of care of the public health—and which comprise, it should be remembered, all matters relating to communal health or disease, from the most abstruse down to the simplest item of municipal scavenging—the dangers just indicated as conducive to epidemic plague carry others with them which are of even greater importance. Darkness, dampness, filth, and bad construction of dwellings are causes of the prevalence of consumption (for example) which annually kills more people than, it may be safely said, plague ever will destroy here during the epidemics which may occur at intervals of years. And these dangers of fostering plague, and plague especially and singularly, are by no means confined to the houses on which they actually exist. Rat-infested premises threaten the inhabitants of every dwelling in average good order which stands within a few hundred yards of them. Numbers of cases of plague occurred, no doubt, on premises which conspicuously presented some or all of the faults just mentioned; but a larger proportion occurred in the dwellings of artisans which were sometimes in good order, at others in an ordinary and fair state, and which laboured under the disadvantage of entirely insanitary methods of connection with sewers, or of the neighbourhood of ancient and dangerous sewers or drains, only within the city of Sydney.

Thus the best, and the only attainable, defence against epidemic plague lies in removal of dangerous conditions which for the most part could not occur under good municipal management, even of the elementary processes of inspection, record, and scavenging.

The epidemic, and the efforts to abate it by cleansing a part of the infected area, revealed to the general public the inefficiency of the work to that time done by some local authorities which, consequently, were loudly accused of neglect. Neglect there had been, no doubt; but, except in the city of Sydney, where large revenues and powers under special Acts of Parliament render excuse difficult, it has been largely unavoidable. There seems to be little ground for hope of important improvement in municipal sanitary administration until local authorities are granted power to strike a sanitary rate, from which the expenses of business-like supervision and improvement of their districts may be defrayed by them.

But funds are not all that is requisite. Knowledge and guidance are also necessary. The Public Health Act provides for appointment of Medical Officers of Health to districts, and to groups of districts. The Board carried out this instruction of the Legislature by combining the populous municipalities in the Metropolitan and Hunter River Districts, and by appointing to each combined district a Medical Officer of Health whose whole time should be devoted to his duties, the opinion having been formed by it that such officers can act efficiently only when they have no other interests. Thus the local authorities administering districts which carry rather more than a third of the total population, were furnished with competent advisers on all matters relating to the public health; for the officers referred to are officers of the combined local authorities, and are not (as they are often taken to be) officers of the central authority. But in the metropolitan district, the local authority for the city of Sydney has power, under its Act of Incorporation (1879), to appoint its own Health Officer. Without reflection on the manner in which the present and past holders of this post have done their duty, it may be pointed out that every incumbent has laboured under those very disadvantages which the Board has striven to remove in the cases just mentioned, namely, of being embarrassed by the cares of private practice, and of being entirely under direction of the Council. It is necessary that the sections of the Act of Incorporation which granted this power should be repealed, and that the city, like other metropolitan municipalities, should be transferred to the care of a medical officer the terms of whose appointment not merely ensure that he shall be skilled in the work which he undertakes, but shall also save him from all those influences which, if they came into play, would seriously impede him in doing it.

The Board, by its use of the opportunity afforded by the Public Health Act, took an important step towards establishment of a public health service on the only basis which renders sound progress possible. It is to be feared that its bearing has, so far, hardly been generally appreciated. And perhaps one reason is that, while providing for the appointment of specially-educated directorial officers, the Act stopped there, and made no provision either for giving sanitary inspectors a similar security of tenure, nor for making sure that they have had reasonable instruction in their special business before they are allowed to undertake it; nor did it co-ordinate them with the Medical Officer of Health, whose assistants and executants, under the local authority, they are. This omission should now be rectified; probably no better plan can be mentioned than that of paying half the salaries of sanitary inspectors in populous districts on condition that they are neither appointed nor discharged except with approval of the Board, which latter would have power gradually to require that every such inspector should produce some certificate or voucher for his having been through a course of instruction in the subjects of which his occupation requires knowledge. There is no doubt that local authorities would gladly accept such an arrangement, which would, besides, relieve them of some local difficulties in executing the law which they now occasionally meet with.

As soon as they are mentioned it will be perceived, doubtless, that these proposals, which were submitted on July 3rd in the form of amendments to the Public Health Act, are of a fundamental character. No efficient execution of health laws need be expected until they have been adopted; and especially no such improvement in scavenging and in buildings as can be a useful defence against incursions of rats is at all likely to be effected until, by means of the organisation sketched above, there is at least a possibility of steadily carrying out the regular inspections, keeping the registers, and causing the improvements which are required.

In special connection with the present subject certain detail amendments of the Public Health Act must be mentioned. The spread of disease by rats is a fact new to practical hygiene; but, for the future, cognisance must be taken of it, and special powers must be given to meet the newly recognised danger. In the first place, premises which on inspection by the proper authority furnish evidence of infestation with rats should be declared to be a nuisance liable to be dealt with summarily by addition of a definition to that effect to those which stand at commencement of the Public Health Act, Part VI. This would give magistrates power to require the owner or occupier to remove wooden floors (if any) in basements and to substitute concrete, to repair walls and effectually stop holes, to guard entrances with wire-netting, to cause doors to close thoroughly, to shield the lower parts of doors with iron plates, to remove accumulations of useless lumber from yards, and to do all other things which might seem necessary in order to prevent a recurrence of the nuisance. Secondly, power should be given to the Board to order vessels lying at wharves and quays to moor with such precautions as are best calculated to prevent free interchange between ship and shore rats, the law at present only permitting such regulations to be made under an Act which applies to public wharves alone. Thirdly, a general building Act not being in force, something of the kind should be substituted without any delay; and in the proposed amendments, already referred to, a way has been suggested by which this might probably be effected without serious difficulty. Fourthly, the law relating to management of epidemics of dangerous diseases should be so altered as to permit medical inspection or surveillance of suspected persons to be used as an alternative to detention at quarantine—namely, so as to make it possible to order persons to live at any address chosen by them, and to present themselves for examination either there or at prescribed times and places. Fifthly, local authorities should be supreme in all health matters not directly undertaken by the central health authority under the Government; their ratepayers should not be subject to the annoyance and confusion caused by liability to receive notices touching the same subject from different authorities as at present they are; but all such notices, from whomsoever emanating, should be given and enforced by the local authority alone. All of these points were also included in the amendments proposed on July 3rd, and, together with those mentioned before, have been approved by you.

It is clear that the beneficial effect of the foregoing provisions, if they were already law, could not be speedily realised. But notwithstanding the singular way in which plague is diffused, it much resembles all other epidemical diseases in this: That there is no royal road to prevention, and that safety can be attained only by steady and long-continued effort. On the other hand, the result of such efforts would tell largely towards prevention of many other diseases which afflict the dwellers in cities. The best internal defence against plague consists in good construction of dwellings and in household and municipal cleanliness, together with the slighter special precautions mentioned above. The origin of this defence lies solely in knowledge of the disease and the mode of diffusion peculiar to it; the possibility of raising it lies with the Legislature; the execution of it lies with local authorities under the Public Health Act, and can lie with no others.

I have the honor to be,
Sir,
Your obedient Servant,
J. ASHBURTON THOMPSON.

APPENDIX A.

Bacteriological Report.

By **Frank Tidswell**, M.B., Ch.M. (Syd.), D.P.H. (Camb.), Principal Assistant Medical Officer of the Government, Microbiologist to the Board of Health.

SYNOPSIS.

1. Initiation of observations.
2. *Bacillus pestis bubonicæ.*
    - (*a*) Morphological characters.
    - (*b*) Cultural characters.
    - (*c*) Pathogenic characters.
3. Observations on the Mode of Infection in Plague.
    - (*a*) Inoculation.
        - (i.) Significance of injuries of the skin.
        - (ii.) Significance of phlyctenules.
    - (*b*) Ingestion.
    - (*c*) Inhalation.

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1. Initiation of Observations.

The bacteriological observations were initiated with sanious lymph obtained from the femoral gland of the first case of the series (A.P.), on January 20th, 1900, the third day of illness. The immediate microscopical examination gave every support to the suspicion of plague roused by the clinical aspects of the case, but in view of the importance of the question at issue, a final pronouncement was deferred pending the completion of the cultural and inoculation tests. The positive results obtained in both of these directions permitted the report of a definite diagnosis of plague on January 23rd, 1900, and the decision thus given received ample confirmation by subsequent observations.

The next point of evidence was secured on February 14th, when, in response to an appeal by the Department, evidence was obtained of excessive mortality amongst rats at one of the wharves in an important business section of the city. On the date mentioned seven rats, three dead and four living, were forwarded for examination, and the microscopical, cultural, and inoculation tests clearly and decisively demonstrated the existence of plague amongst the rats.

On February 24th, femoral and inguinal buboes obtained after the death of the second case in a human being (Case 2) were forwarded, and the series of tests again yielded positive results in all particulars.

From this date onwards throughout the epidemic, a period of four and a half months, practically all the time of the laboratory staff, other than that occupied in the ordinary routine of the laboratory, was taken up by plague work. The demands in this respect comprised examination of specimens from cases in human beings in which the clinical evidence admitted of doubt, or the *post-mortem* appearances were indecisive, or from hospital patients either for information with regard to some particular lesion or symptom, or as to their freedom from infection and safe discharge; examination of rats and other animals taken dead or alive at various parts of the city and suburbs; and observations on the morphology, biology, and pathogenicity of the bacilli isolated from these various sources. The data obtained in these different ways, collected and classified, form the basis of the following descriptions of the more important aspects of the bacteriology of plague.

2. Bacillus Pestis Bubonicæ.—(Figures 1–10.)

(*a*) *Morphological Characters.*

In smear preparations of material from buboes or viscera the micro-organisms were usually present in enormous numbers (v. Figs. 1, 8, 9, 10). As a general rule, the first glance revealed a field teeming with bacilli, and it was very seldom that any lengthy search was required for their detection. The individual elements were isolated, save that here and there two short bacilli were commonly seen end to end in such a position as to suggest recently-accomplished fission, whilst in preparations made from broth-cultures there were sometimes short chains of four to ten bacilli (Fig. 4). In certain specimens, especially those obtained from cases in which the severity of the illness was mild, or in which the acute stage had passed, the bacilli appeared to be enclosed within leucocytes.

Hanging drop preparations usually showed Brownian motion. Here and there an individual element was seen to be vigorously wriggling, but no movement of translation was ever observed. No essential differences in this respect were noted between specimens taken direct from infected tissues, from young or old cultures, from liquid or solid media, or whether examined at the room temperature, or at 37 degrees C. in the Nuttall incubator. It may here be mentioned that staining methods failed to reveal the spiral flagellum described by Gordon, but it is possible that the few wriggling bacilli which may have possessed one might escape detection.

The application of Widal's method was unsuccessful with specimens taken during the early stages of illness, and blood from convalescents, whilst producing imperfect agglutination in one or two instances, was neither constant nor complete in its effect.

The bacilli stained readily with ordinary aqueous solutions of fuchsine, gentian violet, or methylene blue. They did not retain the colour when treated by Gram's method.

In stained preparations the micro-organisms usually had the appearance of a short straight bacillus, but, as a rule, there was considerable variation in the forms presented by the different elements in the same preparation (Figs. 1, 8, 9). In what may be regarded as the mature form, the outline was either that of a typical bacillus, the sides being parallel for the greater part of their length (Fig. 1), or it was whetstone or boat-shaped, the sides being convex outwards (Figs. 6, 10). Interspersed amongst these were rounded, oval, or dumb-bell shaped elements resembling micrococci or diplococci (Figs. 1, 6, 9). The greatest mixture of forms was observed in smear preparations from infected tissues, but there was always a predominance of those above referred to as mature. In young cultures (24–48 hours) the elements were sometimes very minute, and rounded or oval in outline (Fig. 2); but the later growth was usually made up entirely of bacillary forms. As a general rule, the ends were smoothly rounded-off, but in certain preparations were more abrupt, and even irregular.

An occasional element was surrounded by a halo, which could not be demonstrated as a capsule by staining. This appearance was noted only in specimens taken directly from infected tissues. The "stickiness" of many agar-cultures was suggestive of some glutinous envelope or matrix, but nothing of the kind was to be seen in preparations from cultures, even when mounted without previous suspension of water. Spores were not detected.

The average of a number of measurements gave the bacillary forms a length of 1·8 μ, with a variation between 1·6 μ and 2·4 μ. Rarely longer forms were seen. The breadth averaged ·8 μ, and showed little variation, this feature being much more constant than the length.

In young cultures (24–36 hours) the rapidly-multiplying bacilli were sometimes smaller, but after the second or third day they attained the dimensions given above. The rounded forms had a diameter varying between ·5 and 1·0 μ.

The appearance of the unstained specimen indicated aggregation of the protoplasm at the ends of the rods. The deeper colouration of the poles after staining would thus appear to be accounted for by the structure of living bacilli, and not to result from any plasmolytic effect of the processes of drying and staining. But whilst it may be said that the majority of the specimens contained bacilli showing bipolar staining, this feature was far from being a constant character of individual elements. In some specimens it was exhibited by practically every bacillus (Figs. 6, 8, 10); in others a few elements showing it were only found after some search; in others, again, it was no more than suggested, whilst occasionally it was not at all evident. In general, bipolar staining was much more distinct in bacilli obtained directly from infected tissues than in those from cultures. The degree of colouration varied. There was rarely only a comparatively thin band at the poles with the rest of the bacillus clear; more frequently only a small clear space in the middle of the rod, which was otherwise deeply tinted throughout; but most usually the bacilli presented some intermediate condition.

As mentioned below, cultivation upon dry or salted agar readily produced crops of "involution forms" (Fig. 3). In undergoing this process some elements became greatly enlarged, reaching a length of 5 μ or 6 μ and a breadth of 1 μ, but without loss of the shape and staining properties of the original bacillus. They thus represented, so to speak, giant plague bacilli. But other elements became laterally distended as well as enlarged, forming large sausage-shaped, pear-shaped, spindle-shaped, oval, biscuit-like, circular or irregular bodies, staining with a pale uniform colour, and having no resemblance to the bacilli from which they were derived. Many of these metamorphosed bacilli contained clear round spaces (vacuoles), and if these happened to be at the edge the appearance produced was as if a bite had been taken out of them. The more characteristic involution forms have not been met with in the tissues, but the smaller circular bodies, sometimes found in considerable numbers, may, perhaps, represent them. The production of one or other of the forms above mentioned did not appear to depend upon any particular rule. The bizarre shapes were only found in young cultures; as the growth became older, the elements assumed rounded outlines, but sometimes only the latter were present from the first. The ultimate change appeared to be disintegration.

(b) *Cultural Characters.*

The initial cultures with material from infected tissues were usually obtained by inoculation of nutrient agar, coagulated serum, or beef bouillon. Subcultures were grown on other ordinary media (gelatine, milk, potato, &c.)

On agar tubes, inoculated with material from buboes or viscera, and incubated at 37° C., the first noticeable growth usually appeared in 36 to 48 hours, in the form of minute bright specks, very slightly raised above the surface of the medium. In the course of a day or two, the colonies became small colourless hemispheres, ranging from ·5 to 1 millimetre in diameter, then having the appearance of tiny drops of dew. Many colonies never developed beyond this stage; others extended to more or less circular patches having a diameter of 2 or 3 millimetres. When so extending, the slightly raised patch became flat on the surface, and acquired a cloudy opacity, the edges remaining thin and colourless. The cloudiness was also developed when a number of colonies became confluent. Rarely it was present from the first appearance of the colonies. A degree of opacity beyond cloudiness was not seen in growths upon agar. The maximum amount of development appeared to be reached during two weeks incubation; after that time no obvious extension of the growths was observed. When the medium was moist the colonies were apt to fuse into an expansion of irregular contour. Individual colonies were sometimes difficult to pick up, slipping about over the surface of the medium when touched by the needle. The confluent growths were often tenacious and sticky, pulling out into strings. In many instances smaller colourless and large cloudy colonies grew up side by side. The bacilli appeared to be morphologically the same in both, and although no observations were made as to their relative pathogenicity, they probably correspond to the two varieties mentioned by Yersin. In subculture the growth appeared earlier than in the original (24–48 hours), and developed as a confluent streak, raised and cloudy along the middle, but with thin, colourless, iridescent borders often having a fine corrugated appearance. The extreme border was wavy. Sometimes a row of isolated colonies formed along both sides of the streak. The breadth of the streak rarely exceeded 2 or 3 millimetres, except at the lower end, where there was often an expansion 6 or 8 millimetres wide. By rubbing or spreading out a streak, a thin, slightly-cloudy growth was obtained, which gave a ground-glass appearance when looked looked at through the thickness of the agar. With age the growth became more transparent, and often developed a mother-of-pearl iridescence.

Anaërobic cultures gave scanty growths. On agar at the room temperature, the growth was much slower, being seldom distinct in less than five or six days from the time of incubation, and reaching its maximum development in about three weeks. The appearances were very much the same, but the ultimate amount of growth less, than in cultures developing in the incubator. On perfectly dry or salted agar the growth

growth developed in very much the same way as on ordinary agar, resulting in a few days in the production of the involution forms already described. The addition of glycerine or glucose was not found to have any advantage over the simple medium. No redness was produced on slightly alkaline litmus agar, whilst the culture itself often acquired a pale-blue colour from the litmus.

On nutrient (17 per cent.) gelatine, at the room temperature the growth appeared in 3–4 days, and reached its maximum development in the course of the succeeding fortnight. In gelatine tubes, kept in the warmer atmosphere of the incubating room (16–20° C.), the colonies sometimes appeared in 24–36 hours. The general appearance of the surface culture was similar to that upon agar, but often had a white colour. In stab-cultures the growth appeared first in the form of a row of closely-placed, fine granules, which later became more or less confluent, and appeared as a well-marked whitish streak. There was a slowly-growing white expansion on the surface. No liquefaction of the gelatine occurred.

On ordinary serum tubes, inoculated with material from buboes or viscera, and incubated at 37° C., growth usually appeared in 36 to 48 hours after inoculation in the form of small, rounded, cloudy colonies. In their development the colonies reached a diameter of 2 or 3 millimetres, and acquired a creamy colour. In general, the growth was more opaque and more abundant on serum than on agar. Occasionally the serum appeared to be depressed in the neighbourhood of the growth, but there was never any observable liquefaction. In subculture the growth on serum was often visible in 24 hours.

In ordinary beef-bouillon tubes, incubated at 37° C., the growth was usually visible on the second day after incubation. As a general rule, it appeared in the form of fine crumb-like spicules attached to the sides, with more or less deposit at the bottom of the tube, the broth remaining clear and transparent. In other cases a moderate uniform turbidity was produced. No change of colour was observed in neutral litmus agar. No reaction for nitrites nor for indol was obtained, except in a few instances of growths several weeks old, in which, however, the culture appeared to be pure bacilli pestis. Growth in bouillon flasks containing oil resulted in the production of a film, scanty crops of stalactites, and a copious deposit. The number of stalactites present at any one time never exceeded six or eight; they were very fragile, and were noticed to become detached from the film and sink to the bottom of the flask with a worm-like motion. The paucity of growth of stalactites is probably attributable to the fact that the laboratory is subject to a considerable amount of vibration, sometimes marked enough to be distinctly felt, and always such as to prevent micro-photographic work in the daytime. The use of the pepto-gelatine medium of Yersin did not give results obviously better than those obtained with ordinary bouillon.

In milk the growth was much less abundant than in bouillon, and development was effected without change in the appearance of the medium.

On ordinary potato, and also on alkalinised potato, a scanty creamy growth, limited to the lower end of the line of inoculation, developed on only a few of the many tubes inoculated.

(c) *Pathogenic Characters.*

The reports of numerous investigators indicate that plague not only affects man, but is liable to attack several different species of lower animals. Rats, mice, pigs, monkeys, cats, marmots, bandicoots, and pigeons are mentioned as having acquired the disease in a natural way, whilst guinea-pigs and rabbits are the most important items of a long list of animals susceptible of infection by artificial means. In Sydney plague has been found in specimens from human beings, rats, mice, and cats forwarded for examination, and in the laboratory experimental observations have been made upon rats, mice, cats, and guinea-pigs.

The specimens from human subjects of plague comprised materials from buboes, carbuncles, blood, sputum, urine, fæces, and from the viscera in *post-mortem* cases.

The material was obtained sometimes at the initial examination by means of a sterilised syringe; and sometimes from patients in the hospital by the same procedure, or after incision when the gland had suppurated. In a few instances sloughs from buboes were examined. The results of the examinations as regards the detection of plague bacilli are shown by the following statement:—

Material taken.	Number examined.	Result positive.	Result negative.
On 2nd day of illness	1	1	...
„ 3rd „ „	5	5	...
„ 4th „ „	1	1	...
„ 6th „ „	3	3	...
„ 7th „ „	4	4	...
„ 8th „ „	4	3	1
„ 9th „ „	4	4	...
„ 10th „ „	3	1	2
„ 13th „ „	1	...	1
„ 14th „ „	3	...	3
„ 15th „ „	1	1	...
„ 16th „ „	1	1	...
„ 18th „ „	1	...	1
„ 19th „ „	1	...	1
„ 20th „ „	2	...	2
„ 21st „ „	1	1	...
„ 23rd „ „	1	...	1
„ 24th „ „	1	...	1
„ 25th „ „	2	1	1
„ 29th „ „	3	1	2
„ 32nd „ „	2	2	...
Between 33th and 94th day of illness	13	...	13
Total	58	29	29

It will be seen that plague bacilli were forthcoming in 50 per cent. of the specimens; that material taken during the first week yielded uniformly positive results, that bacilli were discoverable up to the thirty-second thirty-second day of illness; but that at later stages, up to the ninety-fourth day, the results were uniformly negative. It may be added that pus from suppurating buboes nearly always gave negative results as regards plague bacilli; it was generally sterile, but sometimes contained micrococci.

Material from carbuncles was examined in three cases, and all gave positive results.

Material from phlyctenules was examined on two occasions, with a positive result in one case.

Blood was taken during life from thirty-two patients either from the finger or from the lobe of the ear. The results were positive in four cases, all of which ended fatally within twenty-four hours after the examination. The negative results were obtained with specimens taken at periods ranging from the second to the seventeenth day of illness.

The sputum was examined in five cases having clinical indications of pneumonia, perhaps primary in one, and secondary in four cases. Plague bacilli were detected in sputum from the possibly primary case, in which they were extremely numerous and practically pure, and in two of the secondary cases in which they were mixed with various other micro-organism.

The urine from twenty-nine patients was received into sterilised bottles, conveyed to the laboratory, centrifugalised, and the sediment examined. Micro-organisms morphologically resembling bacilli pestis were observed in ten of the twenty-nine specimens, but in no instance were they obtained by cultivation or the inoculation of guinea-pigs. In this connection it may be mentioned that no growth was observed in tubes of human urine inoculated from cultures, although other media (agar, serum, &c.) inoculated with the same material, at the same time, showed abundant development. The results were equally negative whether the urine used was sterilised by heat or by passage through the Pasteur-Chamberland filter; and whether left acid or neutralised. As well as the visible evidence, the results were tested by sub-cultivations from the urine tubes on agar or serum, which always remained sterile. But on two occasions growths were obtained from the (alkaline) urine of guinea-pigs dead after inoculation with plague bacilli.

The fæces were examined in twenty cases, microscopically and by plate cultivation, but plague bacilli were neither isolated nor seen.

Plague bacilli have been detected in specimens from various lymphatic glands, spleen, liver, lungs, and blood taken at *post-mortem* examinations on fatal cases. These specimens were submitted for examination as a matter of diagnosis, so that the results are not representative of the intra-corporeal distribution of the bacilli.

The rats forwarded for examination from various parts of the city and suburbs numbered 167. The general results are stated in the following table:—

Condition.	No.	Sick.	Putrid.	Injured.	Result positive.	Result negative.
Living	50	10	....	3	4	46
Dead...........................	117	....	30	22	19	46
Totals	167	10	30	25	23	92

It will be seen that of the 167 rats, plague bacilli were detected in twenty-three, equal to about 12 per cent. In fifty instances the rats were alive, and 117 were dead. Of the fifty live rats, ten were sick and three injured. They were all killed and examined, with the result that plague bacilli were detected in four, all of which were sick on receipt. Of the 117 dead rats, thirty were too putrid for reliable examination, and twenty-two had injuries of such severity and character as to account for their deaths. Plague bacilli were detected in nineteen of the remaining sixty-five rats.

The pathological appearance presented by the tissues of naturally infected rats (Fig. 15 and 16) was briefly as follows:—There was usually general congestion, œdema, occasional excess of fluid in the serous cavities, and minute hæmorrhages under the skin and into various viscera. Enlargement of the lymphatic glands was a common, but not a constant feature, and when present was usually exhibited in several different situations—femoral, inguinal, brachial, lumbar. On two occasions cervical glands and on one occasion a mesenteric gland were found swollen to the size of a pea, but in all three there was great enlargement of glands elsewhere. The swollen glands were not generally discoloured, and though there were sometimes small hæmorrhages under the capsule, the periadenitic swelling and hæmorrhage characteristic of a bubo were never observed. Generally, but not always, the lungs showed patchy pneumonia, and occasionally a few hæmorrhages. The liver was usually enlarged, sometimes to as much as two or three times its normal bulk (Fig. 15), was of a lighter colour than normal, and on a few occasions was mottled with small white points. The spleen was usually swollen (Fig. 15 and 16), in some specimens it was 2 inches long and correspondingly thickened, but occasionally it was not in excess of the normal limits. The suprarenal bodies were frequently of a dark colour, and in a few instances there were small hæmorrhages under the capsule of the kidney. No definite lesions of the gastro-intestinal tract were noted. With the exception of petechial hæmorrhages under the parietal pleura and peritoneum, the remaining parts of the body presented no pathological appearances meriting special mention.

Preparations, cultures, and inoculations with material from the different viscera indicated that the plague bacilli were generally distributed throughout the bodies of the rats, but they were not always detected in the blood, nor in the lungs.

Experimental inoculation of rats was invariably successful; the animals dying after three to four days. The resulting lesions resembled those after natural infection, except that a bubo was produced in the glands corresponding to the site of inoculation.

The mice taken in different parts of the city and suburbs and forwarded for examination numbered six, and plague bacilli were detected in two of them. The pathological lesions were similar to those observed in the rat, but the small size of the organs prevented accurate observations of the finer changes. Experimental inoculation was performed on eight mice. It proved fatal in five, the deaths occurring in two and a half, two and a half, two and a half, three, four and a half days respectively. A bubo was formed in all cases. The mice surviving after inoculation were observed to be very quiet, and ate sparingly between the third and sixth days after injection, but after that rapidly recovered, and became quite lively in the course of the second week. In all three instances the material used, culture or infected organs, killed guinea-pigs inoculated at the same time. In a series of three mice, the first inoculated with material from a bubo in a human patient, and the others with material from the spleen of the preceding mouse of the series, the animals died in two and a half, three, and four and a half days respectively.

Five cats were forwarded, all living, but two were sick. They were killed with chloroform. In the three apparently healthy cats no abnormalities were found on *post-mortem* examination. One of the sick cats had an angry-looking, discharging ulcer at the right angle of mouth, with inflammation of the adjacent mucous membrane extending back as far as the pillars of the fauces. The autopsy revealed general congestion of the tissues, but no œdema, nor hæmorrhages. The lymphatic glands were not enlarged. Pneumonic consolidation of lower part of right lung; other thoracic viscera normal. Spleen slightly swollen and showing numerous grey nodules; liver enlarged and mottled, section had a vague nutmeg appearance, small intestine congested, stomach and large intestine unaffected. Other viscera presented no departure from normal, except as regards congestion. Smear preparations from the ulcer showed a variety of micro-organisms, but none resembling bacilli pestis; those from the spleen contained a minute bacillus, whilst blood, lung, liver, and mesenteric gland were negative. The culture tubes remained sterile, except those inoculated from the ulcer, which gave mixed growths. A guinea-pig inoculated with a portion of the spleen remained unaffected. There was thus no evidence that this animal suffered from plague. The second sick cat was practically moribund on receipt. There was a subpectoral swelling on the left side, near the axilla, about 2 inches in diameter. This was found to have a nucleus of thin pus, surrounded by œdema, but no hæmorrhage, and involved all structures down to the ribs. In the internal organs there was general congestion, slight œdema, but no general hæmorrhages. The pleura adjacent to the pectoral abscess was intensely inflamed. Both lungs showed numerous broncho-pneumonic areas generally about the size of peas, with hæmorrhagic exudation, and sometimes necrotic central points. The bronchial glands were not visibly abnormal. The spleen was very dark in colour, but not obviously altered in other respects. No special lesions were detected in other parts of the body. Smear preparations from the subpectoral pus and œdema contained innumerable plague bacilli (Fig. 9); and preparations from the pneumonic areas were also positive; but liver, spleen, and blood were examined with negative results. Cultures from the subpectoral œdema gave abundant growths, which at subsequent dates produced fatal plague on inoculation into six guinea-pigs and two rats. No differences were observed as regards morphological, cultural, and pathogenic characters between the bacilli obtained from the cat and those derived from man or other animals.

A healthy cat was experimentally inoculated in the thigh with an emulsion of serum-culture in distilled water. Local swelling appeared in two days, with some apparent malaise. The animal was definitely ill on the fifth day, grew steadily worse during the sixth day, was comatose on the evening of the seventh day, and was found dead on the morning of the eighth day after inoculation. *Post-mortem* examination revealed hæmorrhagic exudation at the site of inoculation extending upwards to the femoral region, where a bubo existed. The corresponding inguinal and, to a less extent, the lumbar glands were congested and enlarged. There were no enlarged glands elsewhere. Beyond congestion and slight enlargement of the liver and spleen the organs showed no obvious departure from the normal. Smear preparations from the local exudation, femoral, inguinal, and lumbar glands showed innumerable plague bacilli, and though less numerous, bacilli were also plentiful in the spleen and liver. The lungs and blood gave negative results. Cultures gave vigorous growths.

Guinea-pigs inoculated in the laboratory usually died within four to five days. The exact times ranged from two to ten days, but was rarely longer than six days. No definite differences were obtained in this respect as regards the effect of material from different sources. The inoculations were generally made into the inner side of the knee. The *post-mortem* examinations (Figs. 11, 12, and 13) sometimes revealed hæmorrhagic swelling at the site of inoculation, extending up the leg, but generally there was no such local reaction. In every case there was swelling of the corresponding femoral glands, and usually also periadenitic exudation and hæmorrhage. The related inguinal were frequently, and the lumber glands sometimes, swollen, and occasionally showed periadenitic hæmorrhage (Fig. 13). In some instances other glands were involved, *e.g.*, the deep abdominal, brachial, and cervical groups, and might even show petechial hæmorrhage, but never the appearances observed at the primary bubo. The mesenteric glands were always free from visible alteration. The tissues were generally congested, dusky, œdematous, and very commonly there were petechial hæmorrhages under the skin, serous membranes, as well as in the viscera. The lungs were rarely normal; usually they showed degrees of alteration varying from limited areas of congestion to inflammation of the greater part on both sides (Fig. 11), and petechial hæmorrhages were commonly observed in them. In some cases they were studded with miliary points (Fig. 12). The pericardium and heart rarely showed any changes beyond congestion, and sometimes hæmorrhages. The liver was usually enlarged, sometimes to twice its normal size (Fig. 11). The surface often showed discoloured areas, fine mottling of white points or numerous small hæmorrhages. The spleen was almost invariably enlarged to two or three times its normal size (Figs. 11 and 12), occasionally it was much larger. The surface was usually marked by a variable number of white spots (Figs. 11 and 12), irregularly distributed, and sometimes very numerous. The general colour was much darker than normal, either uniformly or in patches. The edges were thick and rounded. The kidneys were sometimes larger than normal, as a rule pale and marked by hæmorrhages (Fig. 13). The suprarenal bodies were generally swollen and congested, and sometimes of a deep red colour (Fig. 13). The stomach and intestines were usually unaltered in appearance, but occasionally the small intestine was congested. No definite changes were observed in the urinary organs.

The bacteriological examinations showed that occasionally the plague bacilli were practically limited to the site of inoculation and bubo, but that usually they were present in all parts of the body. They were often very abundant in the bubo, in other lymphatic glands, in the spleen, and in the liver. They were not always discoverable in the blood of the heart, even when numerous in the viscera. On two occasions they they were recovered from the urine, but were not found in the bile. Micro organisms, morphologically resembling plague bacilli, were detected in the nasal mucus on three occasions, in all of which there was marked pneumonia.

3. EXPERIMENTAL OBSERVATIONS ON THE MODE OF INFECTION IN PLAGUE.

As opportunity offered, experimental observations were made with the object of instituting comparisons with the reports of other investigators on certain epidemiological aspects of the bacteriology of plague. The work in this respect had to do with various assertions as to the manner in which plague is acquired, and more especially with regard to inoculation, ingestion, and inhalation. The results here reported represent the first fruits of a plan of investigation not yet completed in detail.

(*a*) *Inoculation.*

The experiments described in the foregoing section afford abundant testimony of the susceptibility of various animals to plague bacilli inoculated under the skin, and are in accord with the reports of authorities. It is generally believed that inoculation at some point on the external surface of the body is also the principal mode of infection in man. The significance attached to the occurrence of a bubo is that the inoculation took place through the skin of the region from which lymph is collected to pass through the affected gland. The validity of this inference is vouched for by both clinical and experimental evidence. It has occasionally happened that medical men engaged in investigations on plague have become accidentally inoculated in some particular place, and the resulting bubo has always developed in the glands associated with the part known to be the site of inoculation. Thus Dr. Sticker, a member of the German Commission sent to India to study the plague, received a scratch on the hand whilst performing an autopsy on a plague subject. This small wound was followed by enlargement and tenderness of the glands in the corresponding axilla. A similar sequence of events occurred in the cases of Drs. Aoyama and Ishigami, of the Japanese Commission, who were infected in the same way during their work at Hong Kong. Experimental inoculation of animals always results in a bubo affecting the nearest related group of lymphatic glands. In the observations made in this laboratory, inoculation in the thigh was followed by a femoral bubo, and inoculation in the fore-leg by an axillary bubo. Hence when a bubo is present the entry of infection occurred in the corresponding part of the body, and observers have very generally endeavoured to find indications of it in the patients coming under their notice. As a matter of fact, any such evidence of the exact site of infection is rarely forthcoming. In the great majority of cases searches for such prove futile; no lesions are to be discovered. They had either disappeared by the time the examination was made, or had never existed. This has also been our experience in human beings; and in most of the inoculations on lower animals performed in the laboratory there was no local reaction at the actual point at which the bacilli were injected, all traces of the tiny wounds made being obliterated in the course of a day or two. But in many instances scratches, abrasions, or wounds of the skin have been credited with affording the means of ingress; whilst Simond and some other observers have described the occasional presence of a special local lesion, a phlyctenule, as indicative of the point of entry. Observations on both have been made in this laboratory.

(i) The Significance of Wounds of the Skin.

In a few of our cases in human beings scratches or abrasions were found which might have sufficed to admit the infection, but in all cases, when discharges or scrapings from them were examined, no plague bacilli were detected. The contamination of such wounds with plague microbes involves contact with a plague subject or with some infected inanimate material. The acquisition of plague by direct contagion has been asserted in a few instances, but the conditions under which it is said to have occurred have never been such as to place the matter beyond question. On the other hand, there is abundant evidence that even close association with the plague-stricken, as in hospitals and in most households, does not involve infection. Experimental verification of this fact has also been obtained by many investigators, and was the outcome of the following observations made upon the point in this laboratory:—

1. A healthy mouse was placed in the same jar with another mouse inoculated with material from a bubo. They remained in association during two and a half days, when the inoculated mouse died, and on *post-mortem* examination was found to be generally infected with plague. The other mouse remained perfectly healthy for a period of three weeks, and on being then killed was found to be free from disease.
2. A healthy rat was placed in the same cage with a rat inoculated from a culture. They remained in association during three days, when the inoculated rat died, and was found to be generally infected with plague. The other rat remained perfectly healthy for a fortnight, when it was inoculated from a culture of plague bacilli. It died of plague in three days.

It will be seen that in both instances animals intimately associated with others fatally sick with plague escaped infection, although in one case at least there was no insusceptibility to the disease.

In connection with this aspect of the question some experiments may be mentioned, which were designed to investigate the liability of infection being derived from the surroundings of the sick. On one occasion a mouse, on another a guinea-pig, and on six occasions rats were placed in the uncleaned jars in which animals had died of plague. In no instance did the animal so exposed become infected, although the conditions may be regarded as eminently favourable for mediate contagion. The failure to acquire the disease was not due to insusceptibility, for most of the animals subsequently succumbed to inoculation with plague-cultures or infected organs.

These experiments upon the acquisition of plague from inanimate objects raises the question of the extra-corporeal existence of bacillus pestis. The many experiments which have been performed to ascertain the behaviour of the bacilli under conditions as nearly as possible similar to those in Nature are in general accord in the conclusion that bacillus pestis is not capable of prolonged saprophytic life. As the possibility of the contamination of wounds is most likely to occur from clothing, or from dirt, some experiments on the viability of plague bacilli in such materials were made in this laboratory. The series of experiments is not yet complete, the articles hitherto used comprising only (a) silk and (b) garden soil.

(a.) Small pieces of old soft silk, 1 centimetre square, were placed in a glass double dish, sterilised, allowed to cool, and then soaked in a bouillon-culture. In the first series the excess was removed and the squares placed in the incubator at 37° for about twenty-four hours. They were then removed and kept at the room temperature; pieces being taken at intervals of a few days, and inoculated into bouillon tubes. Growths were obtained up to, but not after, the fourteenth day from the date of infection. In a second series the sojourn in the incubator was omitted, but otherwise the observations were made exactly as before. Again, no growth was obtained in bouillon receiving the squares of silk after the lapse of more than fourteen days from the date of infection. Thus the bacilli on the silk retained their vitality for about a fortnight only.

(b.) In the other experiments baccilli were inoculated from an agar-culture into sterilised garden mould. In some cases the dry culture was mixed with the dry mould, in others the culture was made into an emulsion with sterilised distilled water, and this added in a quantity such as to render the soil merely moist. Samples removed from the dry tubes after six and thirteen days gave no growths in bouillon. Samples removed from the moist tubes continued to give growths up to the twenty-first day. After this the soil had become drier and the subcultures showed no growths.

The two kinds of observations just described are not in themselves adequate proof of brief survival of plague bacilli in natural materials. But taken in conjunction with the results of other investigators, they suggest that the assumption of the derivation of infection from inanimate objects through wounds and abrasions can only be regarded as valid when the contact has clearly been with quite recently-infected articles.

(ii) The Significance of Phlyctenules.

The second kind of local lesion, the phlyctenule, found in plague patients, is ascribed by Simond to inoculation of plague bacilli by fleas—a conclusion at which he arrived as the result of a series of interesting observations which may here be briefly summarised. As the outcome of close inquiry into the circumstances attendant upon the well-known liability to plague infection as a consequence of handling rats dead of the disease, Simond states that a plague rat is dangerous or not, in accordance with the time that has elapsed since it died. If handled soon after death, plague may follow ; but if not touched for some hours, it may then be handled without risk. It was, says Simond, just as if the infection completely evaporated within a few hours after death. He also states that perfectly healthy rats harbour very few fleas, and are very expert in removing them ; but as they become sick they neglect their toilet, and fleas become more and more abundant upon them, so that they sometimes swarm upon moribund rats. After death, on cessation of the circulation, and as the body becomes cold, the fleas leave it and seek another host.

By associating the "evaporation" of the infection with the departure of the fleas, Simond inferred that these parasites were implicated in the transport of the infection. This inference was further supported by clinical observations of two kinds, viz., the site of the bubo, and the existence of a phlyctenule. Simond noticed that persons becoming plague-stricken after handling a dead rat did not necessarily develop their bubo in the axilla. As often as not in such cases the bubo was femoral. Hence the infection was not due to direct contact with the rat, but to some associated circumstance, such as invasion by fleas from the rat. It is obvious that such fleas might inflict a bite and inoculate the bacilli not on the hand or the arm, but on the leg or trunk, and thus produce a bubo elsewhere than in the axilla. He also observed that occasionally a small papule or vesicle—phlyctenule—was present on the area corresponding to the bubo ; and more especially on a part where the skin was thin, *e.g.*, the dorsum of the foot. The occurrence of such a phlyctenule is vouched for by several other investigators, though not all concur in Simond's interpretation of it. This local lesion is not always apparent, and, in fact, in the majority of cases it is not to be found ; but this frequent absence, Simonds contends, is due to the fact that it would only be produced when the inoculated bacilli were of comparatively mild virulence or in small quantity. Under such conditions there would ensue positive chemiotaxis, local leucocytosis and reaction ; whereas, if the bacilli were very virulent, the chemiotaxis would be negative, and no such local reaction occur. Following up these observations, Simond succeeded in detecting plague bacilli in some of the phlyctenules and in fleas from plague rats, and with the latter he produced plague by inoculation of animals. He therefore concluded that if the fleas from the dead plague rat reach another rat or a human being, they may inoculate the bacilli they acquired by ingesting the blood of their former host, and so produce plague ; the site of inoculation being occasionally indicated by a phlyctenule. By way of complete demonstration of his hypothesis, he showed that plague could be conveyed in the way suggested. He placed in a large glass jar a sick rat, and also a healthy animal (rat or mouse), the latter being enclosed in a small cage so as to prevent contact with the sick rat. If he left or placed fleas upon the sick rat, and allowed its body to remain lying in the jar for some hours after death, the healthy animal sometimes developed plague and died ; but if he previously removed all the fleas from the rat and repeated the experiment otherwise precisely as before, the healthy animal did not die, but remained perfectly well.

Simond's observations and experiments were repeated in this laboratory as opportunity offered. As already mentioned, phlyctenules were found in six patients, and smear preparations were obtained from two of them. The examination of the preparations from one proved negative, but those from the other showed a small number of micro-organisms having the morphological characters of plague bacilli. As no further tests were possible, the exact nature of the bacilli remained unascertained. It may here be mentioned that a lesion resembling a phlyctenule was artificially produced in one of the experimental animals. A guinea-pig was inoculated in a small, shaved, sterilised area on the fore-leg, by being pricked with a needle previously sterilised, cooled, and then dipped in a plague-culture. On the following day a small inflamed papule had developed at the site of inoculation, and on the third day, when the animal died, this papule showed a whitish spot at its apex as though about to undergo vesiculation. *Post-mortem* examination revealed the general appearances of plague, including an axillary bubo, and plague bacilli were found in the papule, bubo, liver, and spleen. The production of the phlyctenule in this case corresponds with Simond's hypothesis, inasmuch as the number of bacilli inserted by the process adopted was very much less than in inoculation performed in the usual way, which is not followed by any such lesion.

Examinations were made of fleas from healthy human beings, from a plague patient, from mice, from rats, and from cats. The microscopical examinations all prove negative except in the case of fleas obtained from a rat actually sick with plague. This rat was taken in a house from which a case of plague had been removed five days previously, and in the vicinity of which many persons were attacked. The animal was killed with chloroform, and about a dozen apparently stupefied fleas were obtained from its body. The fleas were crushed up in a few drops of sterilised distilled water, and as preparations from the emulsion so obtained showed micro-organisms resembling plague bacilli (Fig. 5), the remainder of it was inoculated into a guinea-pig. The animal became sick, and died on the seventh day. The *post-mortem* appearances were those of plague, and micro-organisms resembling bacilli pestis were found in the bubo, in the blood of the heart, in the spleen, and in the liver.

In the experiments performed with living fleas, the conditions described by Simond were slightly modified. A rat, selected because of its having many fleas upon it, was inoculated with plague bacilli from a culture and placed in a small wire cage. A second healthy rat was placed in a similar wire cage. The two cages containing the rats were both placed in the same (sheet iron) larger cage, the interval between them being about 2 inches. The inoculated rat died in three days, and its dead body was allowed to remain in the cage for twenty-four hours. It was then removed, and on examination was found to be generally infected with plague. The other rat remained perfectly well for a period of four weeks. The experiment was repeated under exactly the same conditions, except that numerous fleas, obtained by the chance discovery of a mouse's nest, were thrown into the cage, and upon the inoculated rat. This animal also died in three days, its body left twenty-four hours in the cage, and when examined found to be generally infected with plague. A third rat was placed in the uncleaned cage. Neither the first nor the third rat became infected.

It will be seen that the observations we had the opportunity of making in this laboratory gave support to Simond's assertions, as regards the presence of plague bacilli in phlyctenules and in fleas from plague rats, and, whilst the results in the experiments with living fleas were negative, it has to be noted that such tests are obviously liable to miscarry owing to the several uncontrollable factors involved in their performance.

(*b*) *Ingestion.*

Authorities are not agreed upon the question of the acquisition of plague by ingestion of infected diet. In the epidemic at Hong Kong in 1894, plague was said to sometimes take a special form indicating that the infection had entered through the stomach or intestines. This form is said not to have been observed in India, and *post-mortem* examinations have generally failed to reveal evidence of gastro-intestinal infection. No sign of intestinal plague was observed in our own cases. Experimentalists are also at variance—some having succeeded, others having failed, to infect animals by feeding. In this laboratory ingestion experiments were performed by feeding animals with bread, or biscuit, sopped in a bouillon-culture, or in an emulsion of agar-culture; and by the contamination of carrots or bread with, or, in the case of rats, actual feeding upon infected organs. The result of the eleven experiments of this series are shown in the following tabular statement :—

No.	Animal.	Experiment.	Result.
1	Guinea-pig....	Fed with bread; infected from agar-culture	Unaffected.
2	"	" " bouillon-culture ...	"
3	"	" infected liver..................................	Died in 5½ days.
4	"	" "	Unaffected.
5	Mouse	" biscuit, sopped in bouillon-culture.........	"
6	Rat	" bread infected from agar-culture	"
7	"	" biscuit infected from bouillon-culture ...	"
8	"	" liver and sternum of infected rat	Died in 6½ days.
9	"	" " " "	" 10½ "
10	"	" " spleen "	" 4½ "
11	"	" " " "	" 4½ "

The various animals received the infected food on one occasion only, and in all cases a control animal, inoculated with the same material, died in the usual time. It will be seen that whilst feeding with cultures was always unsuccessful, a diet of infected organs proved fatal in one of two guinea-pigs, and in all from rats fed upon it. In the fatal cases there were no signs of external injury such as might result from scratching with infected claws, and no bubo indicating that inoculation had occurred in any such way. Further, in most instances the animals were kept in cages by themselves, so as to prevent fighting, &c., by which inoculation might also be effected. The fact of plague infection was verified by *post-mortem* and bacteriological examinations. The guinea-pig and two of the rats which died showed no gastro-intestinal lesion beyond congestion of the iliac portion of the small intestine, and even this was absent in a third rat. The mesenteric glands were not enlarged in these cases. But in the fourth rat there were well-marked indications of the passage of the infection through the walls of the digestive tract. The stomach and intestines showed fine hæmorrhages, and the ilium and first part of the large intestine were intensely inflamed. Connected with the stomach there was a large deeply-congested lymphatic gland. The blood-vessels in the mesentery were engorged with blood, and the mesenteric lymphatic glands were swollen and fused into a sausage-shaped mass. The cæcal end of the large intestine was involved in hæmorrhagic fibrinous exudation, causing adhesions, and extending into the swollen mesenteric glands. These various changes are shown in Figure 14.

From the results of these experiments, the provisional conclusion is drawn that animals may become infected by ingestion of infected materials. The susceptibility would appear to vary in different animals, rats being more liable to acquire infection in this way than the other species tested. It would seem also that something depends on the exact condition (virulence?) of the plague bacilli with which the food is contaminated.

(*c*) *Inhalation.*

Infection by inhalation is stated to be responsible for plague pneumonia, a fatal form of the disease of which we have fortunately had practically no experience. As in the case of ingestion, so with inhalation experiments, observers have sometimes succeeded, sometimes failed, to infect animals. In this laboratory the only experiments made in connection with this aspect of plague-infection were repetitions of those of Batzaroff, who produced pest-pneumonia by deposition of culture material on the uninjured nasal mucous membrane of rabbits and guinea-pigs, and by smearing the nostrils of rats and mice. The material used by us included culture material, and fresh plague-infected organs, but in five experiments performed the results were always negative.

APPENDIX B.

The Clinical Aspects of Bubonic Plague, as observed in the outbreak of the disease in Sydney during the period commencing 20th January and ending 9th August.

By A. E. Salter, M.B., Ch.M., Melb., in charge of the Isolation Hospital.

During that time, as the subject matter of the report which precedes this has shown, there were 303 cases of this disease reported at the office of the Department of Public Health for New South Wales.

Of these 303 cases, 10 were among persons of the Chinese race, and the remaining 293 among persons of European descent; of the 293 Europeans, 13 had become affected with the disease at some time subsequent to their inoculation with Haffkine's serum.

In order that a comparison may be instituted between persons of the same race only, these 10 Chinese have been kept in a separate group by themselves.

The 293 Europeans have been divided into four groups—the first three according to centuries—the first of these contains the first 100 Europeans reported suffering from Bubonic Plague, the second group contains the second 100 reported, the third contains the 93 remaining after the first 200 have been dealt with, the fourth being made from Haffkine's inoculated cases, which have been picked out from the different groups in which they are scattered and placed in Table 2, in order that the prodromal symptoms with which they were attacked may be compared with the prodromal symptoms of the complete group. Thus we have a total of five groups, which for convenience of reference have been called by the letters A for the first 100 European cases, B for the second 100, C for the remaining 93 Europeans, D for the inoculated persons, and E for the 10 Chinese.

Comparing the first three Groups A, B, C, of the series, to learn when they came under the notice of this Department, it is found that Group A was reported between the 20th January and the 12th April, in fact that these 100 cases developed in a period of 82 days. Group B came to light in 28 days, so that the second 100 cases were produced in slightly more than one-third the time that it took to produce the first 100. The cases of Group C were discovered between 9th May and 9th August, that is in 93 days, or in a period more than three times as long as it took to produce the cases comprising Group B.

As there is this difference between the periods of time taken to produce these three groups, it might be inferred that the virulence of the infection accrued during the first period, reached its zenith in the second, and declined during the third. Yet the death rate among the cases in Group A was 37 per cent., while it was 37 per cent. among the cases in Group B, and 22·6 per cent. among the cases in Group C, which seem to point, if not to a greater virulence in the first portion, to at least an equal virulence, and a study of the incidence of nervous symptoms tends to strengthen the latter inference. Taking a mean of all the temperatures recorded, when the case has been seen for the first time, the mean for Group A is 103·2, the mean for Group B is 102·8, and for Group C it is 102·1, showing that there was a gradual ebb in the temperature wave. Whatever be its cause, the first 100 cases of Bubonic Plague occurred at the rate of 1·2 per day, the second 100 at the rate of 3·5, and the third at the rate of 1 per day. The premonitory symptoms most frequently complained of in each group have been taken out and put into Table 1, and the number of deaths in each set of symptoms has been put down with the object of showing what mode of attack may be regarded most gravely, and therefrom to form a basis for prognosis in the earlier stages from the initial symptoms.

Group A.

From Table 1 it appears that pains in the body, back, and chest were complained of as initial symptons in 23 cases; of these 23 eleven died giving a mortality of 47·8 per cent. Vomiting, not the commonest premonitory symptom, had the second greatest percentage of deaths among those who suffered from it. It was a premonitory symptom in 55 cases, and of the 37 persons who made up the total number of deaths in Group A 26 suffered from this initial symptom so that 47·3 per cent. of the persons affected with vomiting died. Headache was complained of in 72 cases, of them 26 died, giving a percentage of 36, while symptoms referable to the lymphatic glandular system were complained of at the very onset of the attack in 29 cases with 11 deaths. The percentage of deaths among cases presenting this symptom was 37·9.

For purposes of prognosis in Group A pains in the body, back, and chest were most important, vomiting being almost equal. The mean average of all the first recorded temperatures was 103·2.

Buboes.—The lymphatic glandular system was affected in the cases of this group 97 times, while in the remaining 3 no abnormalities were discovered nor referred to by the patient.

From Table 4 it appears that the most frequently affected glands were the right femorals, the next in order being the left femorals, while those next in order were the inguinals, but far behind the two first. The femoro-inguinal regions were responsible for a total of 83 cases, leaving 14 to be divided among all the others when the mortality among these cases is considered it is found that in the 3 cases with no glands there were 3 deaths, and among the 30 cases of right femoral, that there were 10 deaths, among the 25 cases of left femoral that there were 7 deaths. The femoro-inguinal regions with 83 cases were responsible for 25 deaths, while among the remaining glandular regions there were 9 deaths; so that the 14 cases of Bubonic Plague in which the sub-pectoral, axillary, or cervical glands were affected were responsible for 9 deaths showing a percentage of 64·2. The preponderance of mortality was much greater in cases with glandular troubles of the cervico-axillary regions. In 46 cases the buboes were incised. Of these 46 there were 3 operated upon which died subsequently, therefore, 43 of the incised cases recovered and 34 of the deaths took place prior to the suppurative stage being reached, leaving 20 cases in which recovery took place and the buboes resolved, so that of the 63 persons altogether who survived, 68 per cent. suffered from suppuration of their enlarged glands and 30 per cent. recovered with resolution of their glandular affections. Pain or tenderness of the glands at some period of the illness, not necessarily at first—was complained of 57 times altogether.

Secondary Buboes.—These occurred 7 times, but by the expression secondary buboes is meant those buboes occurring after a well-defined term had elapsed between the appearance of the first bubo or chain of buboes, because it was not always easy to determine the order of precedence where several buboes arose in the illness.

Nervous Symptoms (*see* Table 3.)– Symptoms referable to derangement of the nervous system, such as trismus, delirium, coma, semi-coma, staggering gait, thickness of speech, convulsions, screaming, occurred either singly or in combination with each other in 72 cases. Of these 72, there died 28, or a percentage of 38·9 Taking these symptoms separately, coma was seen 4 times, semi-coma 25 times, delirium (ordinary) 33 times, delirium (furious) 17 times, getting out of bed 9 times, hebetude 12 times, speech was affected 23 times, staggering gait is recorded as occurring twice, screaming of a wild and furious nature twice, convulsions 6 times, trismus twice, insomnia 7 times. Spitting: This curious habit occurred in 5 cases; it consisted of a desire to expectorate, though there was no mucous which could be regarded as obnoxious, as far as its appearance afforded opportunity for judgment. The cases which exhibited this symptom would sometimes expectorate right across a ward. If addressed upon the subject they continued their habit, taking no notice of remonstrances, and not trying to avoid any object which might be in the line of fire. Among these 5 there were 3 deaths. It was always regarded as a grave symptom, and in the 2 cases in this group which exhibited it, yet recovered, the train of the symptoms was as follows:—In the first, temperature 104·6, with furious delirium, clammy perspiration, pains in the muscles, irregular pulse, respirations with a frequency of 30 and in the second temperature 103·8, ordinary delirium, pulse very soft 124, respirations 38 and insomnia.

Organs of Vision.—The conjunctivæ were deeply injected in 7 cases; the ultimate result of this injection was as follows:—In two cases considerable mischief to the eyeball took place, the sight of the right eye being quite lost in the one, and considerable corneal impairment supervening in the other. In 3 cases it gradually dispersed, no lesion of the eye taking place; in the other two, though iritis and ulceration of the cornea took place, both recovered and left the Quarantine hospital without any apparent mischief being left behind.

Eruptions of the Skin.—Ecchymotic patches were seen in 6 cases, Erythematous eruptions 3 times, Petechial eruptions twice, Miliary eruptions 3 times, Scarlatiniform once, Eczematous once.

Tongue.—This organ presented the character of being covered with a creamy white fur on the dorsum, and having the tip and edges bright pink and clean in 43 cases.

Septicaemic Cases.—Those 3 cases, with no glandular lesions discoverable during life, died and were not admitted to hospital. The course of their illness in two cases was 30 hours; the third had been ill several days at notification. These may be regarded as Septicaemic cases.

Group B.

The premonitory symptoms of this group are found by reference to table 1 to have been, as in the former group, headache, vomiting, rigours, symptoms referable to the lymphatic glandular system, pain in the back, body, and chest, in the order named as far as frequency is concerned. When the mortality in each set of symptoms is considered, the cases of vomiting are accredited with 40·4 per cent. of deaths, the cases of pains in the body, back, &c., with 36·6 per cent., headache with 31·2 per cent., rigors with 34 per cent., and symptoms referable to the glandular system with 25·6 per cent. For purposes of prognosis in these cases, the vomiting stands the highest in the rate of mortality, pains in the back or body coming next. The mean average of all the temperatures first recorded is 102·8.

Buboes.—The lymphatic glands in this group were affected in 93 cases, and in 7 cases no glandular troubles could be discovered. The left femoral glands were affected alone 21 times, the right femoral alone 16 times. The right inguinal were affected 10 times, and the left inguinal 5 times. Taking inguinal and femoral for both sides together, we find the right groin affected 32 times, and the left groin affected 31 times. To get the femoro-inguinal chain complete there should be added the 4 cases in which both groins were affected in the one individual, and the one case in which the right femoral and left popliteal were affected. The total in this chain for Group B is, therefore, 68. It appears from these observations, and from the observations in Group A, that the femoro-inguinal chains on both sides had about equal chances of infection, and were very much more often affected than the other regions. It must be remembered that the glands of the groin were also frequently affected at the same time as were those of the region next to be considered.

The Axillary Region.—The axillary glands were affected unilaterally once for each side—the cervical glands of the right side once, and of the left side 3 times, in each case unilaterally; but axillary and cervical glands (not considering those just mentioned) were, in combination with some other of the lymphatics, affected 17 times. There were also 1 right and 1 left subpectoral, which are included in the axillary chain. On adding all these together, it appears that the cervico-axillary chain was affected 25 times. The mortality in these two divisions was 19 for the femoro-inguinal chain and 12 for the cervico-axillary chain, being a percentage of 26·4 in the first case and 48 in the second. The most fatal kind were the cervical, as in the 4 cases where the cervical alone were affected 3 died, or 75 per cent. Incision was necessary in the glands of this group in 41 cases. Of the 41 buboes incised there were 2 among them in which death supervened, leaving 39 cases operated upon with recovery, and 34 cases of death without the stage for operation being reached, and 25 in which there was recovery without incision. Taking the cases, therefore, of recovery, viz., 63 in all, it appears that the percentage of them which needed operation was 62, or somewhat less than the percentage needing operation in Group A, while the percentage of cases recovering in which the glandular structures did not break down at all was 39.

Secondary buboes occurred in 17 cases.

Nervous symptoms (*see* Table 3). Symptoms indicating derangement of the nervous system occurred either singly or in combination with each other in 62 cases; of these 26 died, giving a percentage of 42 deaths. Separately they occurred as follows:—Coma, 9 times; semi-coma (not counting it when it went on to coma), 8 times; delirium of an ordinary kind (not counting it when it became furious), 33 times; furious delirium, 15 times; getting out of bed, 18 times; mental hebetude, 6 times; wild delirious screaming, once; convulsions, twice; affection of the speech was noted in 15 cases; insomnia was complained of 5 times; and staggering gait noticed 5 times; spitting occurred in 4 cases, with 3 deaths.

The Organs of Vision.—In this group 4 persons suffered from a deep injection of the conjunctivæ, with the final result that in the case of 1 bilateral iritis, hypopyon and panophthalmitis supervened, with complete blindness. One case cleared up when in hospital, but on returning to work the left eye was found to be weak, and to have a tendency to a recurrence of the injection. The third cleared up completely, and the eyes were strong and well when last heard of. The last of these 4 died before the eyeball became affected.

Eruptions of the Skin.—Erythema occurred 4 times, ecchymoses 4 times, and petechiæ 4 times. In 1 case the body became purple all over sometime before death; in another varicella was just disappearing as bubonic plague came on. Epistaxis occurred in 1 case in this group important enough to require special notice (Case 183).

Septicæmic Cases.—There were 7 cases without glandular symptoms. Of these, 2 were admitted to hospital, the other 5 died too soon in their progress of their illness to admit of removal; of those 2 who were admitted, 1 recovered; the other, after lingering some days, finally succumbed.

Group C.

GROUP C.

As in the previous groups, the same premonitory symptoms were recorded. Forty-nine cases complained of vomiting, and 14 died; 49 also complained of headache, of them 10 died. Pains in the back, etc., were complained of only 13 times, with 3 deaths; rigors occurred in 62 cases, with 14 deaths. Symptoms referable to the glandular system are noted in 34 cases, with 5 deaths. Even when allowance is made for the fact that in this group only 93 cases are under consideration as against 100 in the two previous groups, it would appear that the number of persons complaining of pains in the back and bones had very markedly decreased. The mean average of the first noted temperatures was found to be 102·1.

Buboes.—The inguino-femoral chain in this group produced 58 of the total of 89 cases in which buboes were found, the remaining 31 being divided thus: Axillary and subpectoral regions furnished 16, cervical 4, and the cervico-axillary region combined with some other region, or with each other, furnished 11. There were 4 cases without any buboes, which brings the total up to 93. The mortality as shown in Table 4 points to the same preponderance in the same regions as was noticed in the other groups, the axillary and subpectoral chain being most fatal, with 50 per cent.; the cervical being the next in order, with 25 per cent., until the inguino-femoral chain is reached with 12 per cent. Thirty buboes were incised. Of these 30 incised cases 1 died, and 43 recovered without incision, the buboes resolving. Thus 40 per cent. of the cases recovering needed operation. There were 20 deaths in which no incision was justified. The percentage of cases recovering with resolution was 59·7.

Nervous Symptoms.—Symptoms referable to derangements of the nervous system: Coma occurred in 3 cases, with 3 deaths; semi-coma (not going into coma) in 3 cases, with 2 deaths; delirium (ordinary) in 18 cases, with 7 deaths; delirium (furious) in 6 cases, with 3 deaths; getting out of bed in 7 cases, with 2 deaths; hebetude is noted once, with no deaths; affection of speech in 12 cases, with 2 deaths; insomnia in 3 cases, with 2 deaths; loud screaming in 3 cases, with 1 death; convulsions in 1 case, with 1 death; staggering gait in 2 cases, with 2 deaths. One or more of the foregoing occurred either singly or in combination with each other in 39 cases, or in 42 per cent. of the total admissions. Of these 39 there died 16, being 41 per cent. of deaths. Spitting was observed in 1 case, which was fatal.

Organs of Vision.—The conjunctivæ were deeply injected in 5 cases with following result:—That in 1 case there was some iritis going on to hypopyon, which cleared up the eye, recovering finally, though very weak. Of the other 4 cases, 1 died too early in his illness to show what the future held in store for his eyes, while the remaining 3 never became more than merely conjunctiva injection; finally they cleared up altogether. Eruptions of the skin in this group were: Eczema, once; urticaria, several times; erythema, once; petechia, once; large ecchymosed patches came out in 1 case a short time before death.

Septicæmic Cases.—There were 4 cases in which no glandular symptoms were distinguishable during life. Of these, 2 were admitted to hospital, and 2 were overcome before it was possible to remove them. Of the 2 who were removed to hospital, 1 recovered; the other, after an illness of 9 days, died.

GROUP D.

This group comprises the cases inoculated with Haffkine's prophylactic. They are placed in Table 2 to show how their premonitory symptoms compare with those of the cases in Table 1, where the whole list of cases in each group is dealt with. It is worthy of note that on comparing these two tables it appears that the inoculated cases had milder prodromal symptoms. These persons suffered from vomiting as an initial symptom only 4 times out of the 13, and from pains in the back and body only once. Their glandular regions were affected as follows:—

Swelling of the right femoral occurred 4 times, of them 1 was incised; left femoral 4 times, of them 3 were incised; right inguinal once it was incised; left inguinal twice, 1 was incised; right inguinal and femoral once it was incised; right and left femoral once, and was not incised; right cervical once, and was not incised. Thus of these 14 buboes, 7 were incised, the remainder resolved. As strengthening this comparison, it is to be borne in mind that Table 1 has the advantage of having the inoculated cases included in it, so that it gets the benefit of their less-marked symptoms.

GROUP E.

Chinese.—There is not much to be said of this group, because of the 10 persons who were attacked 7 were discovered in extremis. Those whose faculties were not completely clouded by the intoxication of their disease were unable to speak English well, and could not give much information. Two out of 10 recovered, and of them 1 suffered the loss of an eye as a result of the injection of the conjunctivæ followed by iritis and panophthalmitis. Both eyes were affected with iritis, but in the 1 case it cleared away, and good vision has remained in this eye, while total loss of vision resulted in the other. The buboes recorded were 1 right inguinal, 1 right inguinal and femoral, 1 right and left inguinal, 1 left axillary, 1 left cervical, 1 right and left cervical, 1 right femoral. Three had no buboes, as far as can be ascertained. That case with the right inguinal and femoral gland affected, and that case with the right femoral affected, are the 2 which recovered. In both cases the buboes were incised. In 1 of the Chinese a carbuncle formed on the right hip. He recovered. Of the 10 who were attacked, 5 were admitted to hospital, the other 5 died before they could be removed. Of the 5 admitted to hospital, 2 recovered, the remainder died.

Taking all the cases together, reference must be made to a symptom exhibited by a few cases, and not referred to in the detailed account, viz., swelling of the legs, especially of the thigh. The swelling was not odematous. No glands were perceptible to the touch, and there was no tenderness in any of the glandular regions.

This occurred only occasionally during the acute febrile stage of the disease, and in some cases death supervened, in others recovery.

That swollen condition frequently seen during and after convalescence is not the swelling now referred to. This last was fairly frequent, and was doubtless caused by the impediment to the return circulation resulting from a healing bubo.

The first took place when there had been no apparent bubo.

Hæmorrhages.—Those hæmorrhagic effusions occurring under the skin in cases of bubonic plague have been dealt with in the various groups under the heading of eruptions of the skin.

Under the present heading the symptom referred to is an unnatural discharge of blood, sufficient in quantity either to threaten the life of the patient, or being poured into some important organ to cause the destruction of that organ.

Although hæmorrhage from the lungs, in the form of hæmoptysis, occurred in about half of the cases in which the secondary cause of death is set down as apnœa, that form of hæmorrhage is not meant here. It never occurred in sufficient quantity to endanger life.

Epistaxis.—This was not at all frequent, even in a mild form, although it was seen occasionally. I had no bearing on the cases, and did not happen in the earlier course of the fever, excepting in one case. This was one of those cases in which the hæmorrhage was excessive enough to be a source of danger to the patient. It was stopped only with difficulty, and later on death supervened, and appeared to have been accelerated by the loss of blood. Hæmorrhage from the stomach occurred twice in such large volume that it caused the collapse of the patient. It came on suddenly, and lasted for but a few minutes, very large quantities of dark red blood being ejected.

The patients admitted to Quarantine hospital were suffering from an acute febrile disease, having prevailing characteristics distinguishing them from the ordinary run of febrile diseases met with in general practise.

Those characteristics were most commonly some affection of the lymphatic glands, such as swelling, pain, or tenderness referable to one or more of the glandular regions. Considerable mental disturbance usually appearing in the form of drowsiness and a general appearance of being very ill without any cause being found. These indications were accompanied by marked disturbance in the circulation, concerning which nothing has been said in the detailed report of the symptoms. The pulse, in all cases where it was evident from other indications that the person under consideration was very ill, had characters which were in sympathy with the general condition; it was usually accelerated and compressible; sometimes dicrotic, sometimes intermittent; and was always watched with the greatest care.

In cases where the illness was prolonged past the stage of acute plague, the pulse would often be found accelerated, and as many as 120 or 130 beats to the minute without any marked rise in temperature. This acceleration was not reduced by the exhibition of such drugs as digitalis and strophanthus, although given in large continuous doses. It seemed that where the disease left the pulse with those characteristics it gradually returned to its natural condition of its own accord. The respirations were accelerated not, however, on account of any mischief being present in the structure of the lung itself, but irrespective of lung complications, and in cases that were about to end fatally that increase would gradually continue until as many as fifty per minute would be recorded. During the month of May and thereafter the character of the symptoms, as shown by the cases on their admission to the Quarantine hospital, changed. It was conjectured from the alteration in the type of the cases received that the outbreak was coming to a conclusion. Cases were admitted but seldom in which unconsciousness was present. Usually the cases showed very little indications of being very ill. Either some fever or glandular trouble was present, generally there were both, but other constitutional symptoms were less frequent. Not only was the mean average temperature lower, but there was a diminution in frequency in the derangement of the nervous system. This is evidenced by the fact that the records of the cases show that the frequency of certain nervous symptoms, either alone or combined, was in Group A, 72 per cent.; in Group B, 62 per cent.; but was in the cases of the last ninety-three only 42 per cent. (*see* Table 3). This marked alteration was not due to any particular method of treatment adopted; it was due to the difference in the type of the cases. The 72 or 62 or 42 per cent. of the persons who suffered from the nervous symptoms detailed did so from the time of their admission to Quarantine; patients were, in the early part of the outbreak, for the most part in a drowsy or semi-conscious state when admitted. In the latter part of the outbreak these symptoms were conspicuously absent in the patients when admitted. Indeed, no such thing as a case entering Quarantine with mild symptoms, and getting worse or dying, ever happened. The first 200 cases were, with some exceptions, either delirious or drowsy or in a comatose state when they were received, but more than half the latter cases were quite conscious, mentally clear, and not inclined to believe that they were seriously ill, nor did they turn out to be so. Probably the source whence the infection was being received was no longer producing such virulent material, but whatever be the reason it is certain that the type of the disease was becoming modified.

Cause of Death.—In considering the secondary cause of death, only those cases which were admitted to Quarantine and died there are referred to.

The number of these is 64, leaving 39 who died elsewhere, the end having come either too quickly to permit of their removal, or else, as no doubt happened in the case of some of the Chinese, the fact of the individual's illness did not become known until he was in a moribund condition, or perhaps actually dead.

The secondary cause of death is as follows:—

Cardiac failure.—Failure of the central organ of circulation was the secondary cause of death in 26 cases—that is to say, the heart gradually grew weaker and weaker until death supervened.

Apnœa.—In 24 cases the patients were really asphyxiated. There was a collection of thin mucous in the trachea and bronchi; sometimes there was hæmoptysis. Abnormal chest sounds were not always discernible.

The condition seemed to be as if the mucous membrane of the bronchi was affected similarly to the mucous membrane of the eye, and by the same irritant. (The same irritant no doubt was at work on the mucous membrane of the fauces in the cases where spitting was a prominent symptom.)

Exhaustion.—In 5 cases the patients, having got through the acute stage of plague, seemed unable to recover their vitality. The digestive organs did not act, or there was continuous vomiting, or the rate of the pulse, as has already been stated, became very high, and did not respond to the drugs which were exhibited. The nervous system seemed to have received permanent injury, and they died ultimately of exhaustion, after an illness of from thirteen to ninety-eight days.

Convulsions.—These were the secondary cause of death in 6 cases, and of them there was a previous history of convulsions in one case only; but, probably, if the facts could have been traced, it would have been found that a family history of convulsions existed in the majority.

Hæmorrhage.—Hæmorrhage from the stomach (already mentioned among the hæmorrhages) was so profuse as to terminate life suddenly in 2 cases.

Coma.—In 1 case the patient was in a profound coma, and continued so until death, being in that condition a little over two days.

TABLE

TABLE 1 showing the number of times the symptoms mentioned occurred as the earliest observed symptoms of illness in 293 whites, divided into three arbitrary groups containing—in Group A, 100 cases, 20th January to 12th April; in Group B, 100 cases, 12th April to 9th May; and in Group C, 93 cases, 9th May to 9th August;—together with the number of Deaths which occurred among patients having the symptoms as specified.

Symytoms occuring at the onset of illness.	Group A.			Group B.			Group C.			Totals.		
	No. of Cases in which the Symptoms mentioned occurred at onset.	No. of Deaths among Cases in preceding column.	Per-centage of Deaths.	No. of Cases in which the Symptoms mentioned occurred at onset.	No. of Deaths among Cases in preceding column.	Per-centage of Deaths	No. of Cases in which the symptoms mentioned occurred at onset.	No. of Deaths among Cases in preceding column.	Per-centage of Deaths.	No. of Cases in which the symptoms mentioned occurred at onset.	No. of Deaths among Cases in preceding. column.	Per-centage of Deaths
Vomiting	55	26	47·3	57	23	40·4	49	14	28·5	161	63	39·1
Pains in the back, body and chest bones.	23	11	47·8	30	11	36·6	13	3	23·	66	25	37·9
Headache	72	26	36·	64	20	31·2	49	10	20·4	185	56	30·3
Rigors	32	10	31·2	50	17	34·	62	14	22·5	144	41	28·5
Symptoms referable to the Lymphatic Glandular System, as pain or swelling.	29	11	37·9	43	11	25·6	34	5	14·7	106	27	25·5

TABLE 2 showing the number of times the symptoms mentioned occurred as the earliest observed symptoms of illness i thirteen patients who had been inoculated with Haffkine's prophylactic, at dates before attack, which varie between one day and thirteen weeks, for comparison with Table 1, in which they are also included.

Consecutive No. of Case	36	37	41	42	44	47	51	57	66	103	115	214	285	Total.
Vomiting	...	...	...	•	...	...	...	...	...	•	•	•	...	4
Pains in Back, Body, &c.	...	...	...	...	...	...	...	...	...	•	...	...	...	1
Headache	•	•	•	•	•	•	•	•	...	...	•	•	•	11
Rigors	...	...	...	...	...	...	...	...	...	•	...	•	•	3
Symptoms referable to the Lymphatic Glandular System, as pain or swelling.	•	...	...	•	•	•	•	•	•	...	•	•	•	10

All the patients referred to in Table 2 recovered.

TABLE 3 showing the number of times that one or more of the following symptoms, indicating derangement of th Nervous System, were observed in the patients constituting each of the three Groups at admission to hospita and the percentage of the total number in each Group who were affected thereby.

Symptom.	Group A (First 100 Whites).				Group B (Second 100 Whites).				Group C (Remaining 93 Whites).				Totals.				
	No. of times observed.	No. of Deaths among Patients in whom the respective symptoms were observed.			No. of times observed.	No. of Deaths among Patients in whom the respective symptoms were observed.			No. of times observed.	No. of Deaths among Patients in whom the respective symptoms were observed.			No. of times observed.	No. of Deaths among Patients in whom the respective symptoms were observed.	Percentage of Deaths.		
Coma	4	3	Total number of cases in this group in which one or more of the foregoing symptoms were observed = 72 (or 72 per cent.)	Percentage of deaths among the above = 38·9 per cent.	9	3	Total number of cases in this group in which one or more of the foregoing symptoms were observed = 62 (or 62 per cent.)	Percentage of deaths among the above = 42 per cent.	3	3	Total number of cases in this group in which one or more of the foregoing symptoms were observed = 39 (or 42 per cent.)	Percentage of deaths among the above = 41 per cent.	16	9	56·2	Total number of cases in which one or more of the foregoing symptoms were observed = 173 (or 59 per cent. of total number of patients).	Percentage of deaths among the above = 40·5 per cent.
Semi-coma (not ending in Coma)	25	17			8	2			3	2			36	21	58·3		
Delirium (ordinary)	33	12			33	10			18	7			84	29	34·5		
,, (furious)	17	8			15	10			6	3			38	21	55·3		
Getting out of bed	9	6			18	13			7	2			34	21	61·8		
Hebetude	12	6			6	...			1	......			19	6	31·6		
Affections of speech	23	11			15	8			12	2			50	21	42·0		
,, gait	2	1			5	2			2	2			9	5	55·5		
Trismus	2	1			...	......			...	......			2	1	50·0		
Furious screaming	2	......			1	1			3	1			6	2	33·3		
Convulsions	6	4			2	2			1	1			9	7	77·7		
Insomnia	7	......			5	3			3	2			15	5	33·3		

Regional Buboes.			(First 100 Whites.)		(Second 100 Whites.)		(Remaining 93 Whites.)		Group D.	(10 Chinese.)		No. of Cases.	Deaths	Per-centage of Deaths.
			No. of Cases in which Symptoms mentioned occurred.	No. of Deaths among foregoing.	No. of Cases in which Symptoms mentioned occurred.	No. of Deaths among foregoing.	No. of Cases in which Symptoms mentioned occurred.	No. of Deaths among foregoing.		No. of Cases in which Symptoms mentioned occurred.	No. of Deaths among foregoing.			
Femoro-Inguinal Chain only.	Right.	Femoral	30	10	16	4	12	2	The cases in Group D are those of inoculated persons, and have been reckoned in the previous columns of this Table.	1	...			
		Inguinal	5	2	10	2	10	1		1	1			
		Femoral and Inguinal	3	1	5	1	4	...		1	...			
		Femoral or Inguinal	1	...	...	...	...	...		...	...			
		Femoral, Inguinal, and Illiac	1	1	1	1	...	...		...	...			
		Groin	1	...	..	...	...	...		...	...			
			41	D. 34·1 % 14	32	D. 25 % 8	26	D. 11·5 % 3		3	D. 33·3 % 1	102	26	25·5
	Left.	Femoral	25	7	21	7	16	3		...	...			
		Inguinal	8	2	5	2	5	...		...	...			
		Femoral and Inguinal	7	1	5	1	7	...		...	...			
		Femoral, Inguinal, and Illiac	1	1	...	...	...	...		...	...			
		Groin	1	...	...	...	...	...		...	...			
			42	D. 26·2 % 11	31	D. 32·2 % 10	28	D. 10·7 % 3		...	...	101	24	23·7
	Bilateral.	Right and Left Femoral	...	...	3	...	...	...		...	...			
		Right Femoral and Left Popliteal	...	...	1	...	...	...		...	...			
		Right and Left Femoral and Left Inguinal	...	...	1	1	...	...		...	...			
		Right and Left Inguinal	...	...	...	...	3	...		1	1			
		Right Femoral and Left Inguinal	...	...	...	...	1	1		...	...			
			...	...	5	D. 20 % 1	4	D. 25 % 1		1	D. 100 % 1	10	3	30·
			83	D. 30 % 25	68	D. 28 % 19	58	D. 12 % 7		4	D. 50 % 2	213	53	25·
Axillary Chain.		Right Axillary	1	1	1	...	7	5		...	...			
		Left Axillary	4	2	1	...	2	...		1	1			
		Right and Left Axillary	1	1	3	1	3	1		...	...			
		Right Subpectoral	2	2	1	...	3	1		...	...			
		Left Subpectoral	...	...	1	1	1	1		...	...			
		Right Subpectoral and Right Axillary	...	...	1	...	..	..		...	...			
			8	D. 75 % 6	8	D. 25 % 2	16	D. 50 % 8		1	D. 100 % 1	33	17	51·5
Cervical Chain.		Right Cervical	2	...	1	1	3	...		...	...			
		Left Cervical	2	2	3	2	...	...		1	1			
		Parotid	1	...	...	...	...	...		...	...			
		Right and Left Cervical	...	...	...	...	1	1		1	1			
			5	D. 40 % 2	4	D. 75 % 3	4	D. 25 % 1		2	D. 100 % 2	15		53·3
Axillary, Cervical, and Others Combined.		Right Axillary, Cervical, and Femoral	1	1	...	...	...	...		...	...			
		Right Femoral, Right and Left Axillary, Left Cervical	...	...	1	1	...	...		...	...			
		Left Cervical and Left Axillary	...	...	1	...	1	1		...	...			
		Right Femoral, Left Axillary, Right and Left Cervical	...	...	1	...	...	...		...	...			
		Right Femoral and Left Axillary	...	..	1	1	1	1		...	...			
		Right and Left Cervical	...	...	1	1	...	...		..	...			
		Right and Left Femoral and Cervical, and Right Axillary	...	..	1	1	...	..		...	...			
		Right Axillary, Right and Left Femoral	...	...	1	...	...	...		...	...			
		Right Cervical and Left Axillary	...	...	1	...	1	..		...	...			
		Right and Left Cervical, and Left Femoral	...	...	1	1	...	...		...	...			
		Right and Left Axillary, Right Supratrochlear	...	...	1	1	...	...		...	...			
		Right Femoral and Axillary	...	..	1	1	1	...		...	...			
		Right Femoral, Left Cervical, and Illiac	...	...	1	...	...	...		...	...			
		Supratrochlear and both Cervical	...	...	1	...	...	..		...	...			
		Sublingual and Left Cervical	...	...	...	...	1	...		...	...			
		Right Inguinal and Axillary	..	...	...	...	1	...		...	...			
		Right Inguinal, Femoral, and Cervical	...	...	...	...	1	...		...	...			
		Right Axillary and Cervical	...	...	...	...	1	...		...	...			
		Right Brachial and Axillary	...	...	...	...	1	...		...	...			
		Right Femoral, Inguinal, Right and Left Cervical	...	...	...	...	1	...		...	..			
		Right Cervical, Left Subpectoral	...	...	...	...	1	...		...	...			
			1	D. 100 % 1	13	D. 53·9 % 7	11	D. 18·2 % 2		...	...	25	10	40·
		Totals	... 97	D. 35 % 34	93	D. 33·3 % 31	89	D. 20·2 % 18		7	D. 71·4 % 5	286	88	30·8
		Cases in which no Buboes occurred (Septicæmic)	... 3	D. 100 % 3	7	D. 86 % 6	4	D. 75 % 3		3	D. 100 % 3	17	15	88·2
			100	37	100	37	93	D. 22·6 % 21		10	D. 80 % 8	303	103	34·

A. E. SALTER, M.B.

APPENDIX C.

Notes on some Lesions of the Eye; by C. Gordon McLeod, M.B., Ch.M.

On April 14th I visited the Quarantine Hospital at North Head, and examined four patients suffering from eye trouble. They were as follows:—

Case 10.—Right eye; large superficial corneal ulcer of dendritic type; little photophobia; moderate ciliary congestion; no hypopyon.

Case 17.—Right eye; extensive exudation of pure lymph in anterior chamber; subsiding iritis, with closed pupil. No keratitis.

Case 86.—Both eyes; slight attack of simple iritis.

Case 40.—Left eye; small central cornial ulcer, with considerable iritis.

In case 17, the eye lesion appears to be specific to the general disease from which the patient is suffering. The entire absence of outside causes points to a septic embolus setting up a disastrous intra-ocular suppuration.

As to the other cases, there is nothing in the appearances to distinguish them from similar trouble occurring under many other circumstances; but as keratitis and iritis have been frequently noted in the course of plague, their presence here is probably more incidental than accidental.

APPENDIX D.

Post-mortem notes made on twenty-four cases of plague by the Government Pathologist (Dr. G. H. Taylor), by the Pathologist to Sydney Hospital (Dr. Sydney Jamieson), and by Dr. F. P. Sandes, Resident Medical Officer, Prince Alfred Hospital.

Case 22. *March* 17. *F., æt.* 14. *Duration of illness,* 30 *hours.*

Body well nourished. Skin pale. No enlarged glands. Hæmorrhage around the femoral glands, but no œdema. Arachnoid and pia mater much congested. Small hæmorrhages scattered over pulmonary pleura, upper surface of diaphragm, costal pleura, surface of heart, interior of heart and pericardium, the capsule of kidneys, and surface of intestines. Several of these hæmorrhages appeared to have a slightly necrotic centre. Hæmorrhage into the mucous coat of stomach. The hæmorrhages varied in size from a pin's head to a three-penny piece. The lungs were congested and œdematous. The liver slightly fatty. The spleen normal in size and firm. Colour of splenic pulp a dark red. Dr. Armstrong removed a piece of the spleen. G.H.T.

Case 58. *April* 1. *M., æt.* 43. *Duration of illness,* 7 *days.*

External appearances.—Fairly well nourished. Body pale. Rigor mortis universally present. *Post-mortem* lividity very marked over dependent parts of body. A few small livid petechiæ, about size of pin-heads, were found in the anterior aspects of both legs.

Lymphatic Glands.—The axillary, brachial, and inguino-femoral glands were dissected out. In the case of the latter groups some of the glands were slightly enlarged, and on section were softened and somewhat mottled, but no hæmorrhagic extravasation was found around them.

Thorax.—Cavities: Contained no subserous hæmorrhages and no excess of fluid.

Lungs.—Both were somewhat congested and slightly œdematous, but were otherwise normal. The glands at the roots of the lungs were normal in appearance. No petechial hæmorrhages were found in the pleuræ.

Heart (weight 10¾ oz.).—Both ventricles were filled by pale yellow gelatinous clot, which was tightly adherent to the meshes of the columnæ carneæ. Otherwise the organ was healthy looking.

Abdomen.—Peritoneum healthy. No petechial hæmorrhages.

Liver.—Enlarged (weight, 5 lb. 8¾ oz.). It was of a uniform yellow colour, and of soft consistence. This was found microscopically to be due to an extensive fatty degeneration of the liver.

The gall-bladder and its contents appeared normal.

Stomach and Intestines.—In the stomach were numerous submucous extravasations of blood, especially towards its cardiac end. The mucous membrane was corrugated and covered by a thick, glairy, tenacious mucus.

The mucous membrane of the intestines was slightly congested, but otherwise normal.

Genito-urinary System.—Right kidney (6¾ oz.): Organ swollen, and of soft consistence. Its cortex was pale and swollen. On section the kidney substance overlapped the divided capsule. The capsule was thin, translucent, and non-coherent.

Left Kidney (7¼ oz.).—Similar to its fellow.

Microscopically the kidneys showed proliferation and desquamation, with cloudy swelling of the tubular epithelium, and also of the epithelial lining of the Bowman's capsules.

The bladder and ureters showed nothing abnormal.

Hæmopoietic System.—The spleen was enlarged; somewhat softer than normal. On section the pulp had a brownish-red colour, and the trabeculæ were obscured by the swelling of the pulp.

The mediastinal and mesenteric glands were unaffected, but chains of vessels running along both iliac vessels were somewhat enlarged and redder than normal.

Nervous System.—The brain showed nothing abnormal save some slight excess of fluid beneath the lepto-meninges.

Films from the spleen pulp and the blood of the right median basilic vein were made and stained by dilute aqueous solution of fuchsin, and showed numerous short oval-shaped bacilli, many of which showed characteristic bipolar staining.

Films were also stained by Gram's method, and showed the bacilli to be decolourised. S.J.

Case 78. *April* 6. *M., æt.* 18. *Duration of illness,* 72 *hours.*

Body pale, but cyanosed. Numerous small excoriations in both forearms, the result of scratching—resulting from the irritation of mosquito bites. Some abrasions on lower parts of both legs. No petechiæ. The inguino-femoral glands and the glands above Pouparts' ligament on the right side were enlarged.

Thorax.—Cavities : Nil.

Lungs.—Nothing abnormal, except a few small petechial hæmorrhages. Heart.—Muscle apparently healthy. All its cavities were completely filled by pale yellow gelatinous clot, firmly adherent to columnæ carneæ. Valves and aorta healthy.

Abdomen.—Liver : Enlarged and mottled. Gall, bladder, and bile apparently normal. Stomach and intestines.—Mucosa of stomach swollen and mamillated, and covered with ropy mucus. Numerous petechiæ in the submucous coat. In some parts of the large intestine there were many submucous hæmorrhages, some as large as a three-penny piece.

The mesenteric glands were enlarged, but not hæmorrhagic.

Genito-urinary System.—Kidneys enlarged, and softer than normal. Cortex swollen and pale. No hæmorrhages in substance or capsule. Capsule stripped readily.

Bladder and Ureters.—Healthy.

Hæmopoietic System.—Spleen : Slightly enlarged, and somewhat soft. On section of a dark reddish-brown colour.

Nervous System.—Brain healthy. The iliac and inguino-femoral glands on the right side were enlarged and softened. On section they were dark and mottled, and there was a considerable amount of peri-capsular hæmorrhage. There was also marked œdema (inflammatory) of the retro-peritoneal tissue in both iliac regions.

The blood, spleen, and enlarged glands all showed numerous plague bacilli. S.J.

Case 79. *April* 6. *F., æt.* 61. *Duration of illness,* 7 *days.*

Heart and lungs not examinad. Axillary glands enlarged. Femoral glands not increased in size. Liver normal in appearance. No superficial hæmorrhage. Spleen enlarged somewhat, soft, darker colour than normal ; no superficial hæmorrhages. Intestines normal. Mesenteric glands firm and rather prominent. Kidneys healthy. F.P.S.

Case 84. *April 7th. M., æt.* 3. *Duration of illness,* 51 *hours.*

External appearances.—Rigor mortis universally present. *Post-mortem* lividity well marked. Numerous petechiæ on chest, abdomen, and legs. No definite bubo to be made out.

Thorax.—Cavities : Empty. No petechial hæmorrhages.

Lungs.—Somewhat congested. There were a few petechial sub-pleural hæmorrhages, otherwise nothing abnormal found.

Heart.—Showed nothing abnormal except some pallor of its muscular walls.

Abdomen.—Peritoneum : No petechiæ ; no abnormality observed.

Liver.—Somewhat enlarged and softened. It was very much mottled in appearance, and was found to be the seat of an extensive fatty degeneration.

The gall bladder and its contents showed nothing unusual.

Stomach and Intestines.—The stomach showed a few submucous hæmorrhages. The small intestine showed some swelling and infiltration of the solitary glands and Peyer's patches. Throughout the whole length of the intestines were found numerous small submucous hæmorrhages.

The pancreas was the seat of a somewhat extensive hæmorrhagic extravasation, both into its substance and beneath its serous coat.

Genito-urinary System.—Right kidney was enlarged and softer than normal. The capsule was tightly stretched over the organ. It stripped readily. No hæmorrhagic extravasations were found either in the substance of the organ or beneath its capsule.

The cortex was pale and swollen, and found to be the seat of an early catarrhal nephritis (microscopically).

Left kidney similar to its fellow.

Bladder and ureters.—Healthy.

Hæmopoietic System.—The spleen was enlarged and of subnormal consistence. Its pulp was of a light brownish-red colour, and its trabeculæ were obscured.

The lymphatic glands along the course of the iliac and femoral vessels were slightly enlarged and of a dark-red colour. On section they were found to be of soft consistence and to be markedly mottled. Around these enlarged glands was an area of subserous hæmorrhages.

The brain showed no abnormality.

Microscopic examination of the spleen pulp and blood was made, and enormous numbers of typical plague bacilli were found.

The blood, in addition, was found to show a very extensive leucocytosis and there were present also numerous myelocytes and nucleated red corpuscles. S.J.

Case 93.

Case 93. *April* 9. *M., æt.* 22. *Duration of illness,* 36 *hours.*

Died 8th April. Body, face, and neck cyanosed. No petechiæ. Femoral, inguinal, and iliac glands, red in colour and mottled in section, not enlarged: surrounded by hæmorrhage. Lungs œdematous and congested with numerous small sub-pleural hæmorrhages. Hæmorrhage in pericardium and surface of heart. Heart contained dark clots. Liver mottled with patches of fatty degeneration. Spleen slightly enlarged and softer than normal. A few hæmorrhages on surface of intestines. A few submucous hæmorrhages in stomach. Large sub-capsular hæmorrhages in kidney.

Death reported to coroner as due to plague. Spleen and blood afterwards examined by Dr. Bowker, who confirmed the opinion, which was quite clear from the *post-mortem.* G.H.T.

Case 111. *April* 13. *M., æt.* 36. *Duration of illness,* 36 *hours.*

The body was that of a well-nourished and fairly muscular man; skin pale, and face placid. Hæmorrhage around the inguinal bubo, and œdema; hæmorrhage around the femoral, iliac up to the lumbar glands. A few petechiæ in the pulmonary pleura. Lungs œdematous. Dark soft clots on both sides of heart, with soft pale clot in right ventricle. Muscle and valves normal. Scattered hæmorrhage in posterior mediastinum. Hæmorrhage around round ligament of liver. Scattered petechiæ on surface of liver. Subserous and submucous hæmorrhages in gall-bladder. Hæmorrhages into pancreas and into retroperitoneum and surface of kidneys. Spleen normal in size and consistence, dark red in colour. Many small areas of congestion in arachnoid, which, from simple inspection, resembled hæmorrhages (small).

G.H.T.

Case 114. *April* 15. *M., æt.* 62. *Duration of illness,* 48 *hours.*

Body fairly nourished. Numerous petechiæ all over the body. No wounds or abrasions of any sort. Double inguinal hernia. Decomposition signs showing in legs and lower abdomen.

Thorax.—Lungs: Both were markedly congested. A few small sub-pleural hæmorrhages.

Heart.—A few sub-epicardial hæmorrhages. Marked *post-mortem* staining of the endo-cardium. Heart muscle soft and flabby. Badly formed pale clots on both sides.

Abdomen.—Liver: A few small sub-capsular hæmorrhages. Organ slightly pale, but no marked fatty change. Consistence soft.

Stomach.—Showed some small hæmorrhages near the pyloric end.

Kidneys.—Very soft, and somewhat swollen. Cortex swollen, especially the inter-pyramidal portion.

Bladder and Ureters.—Showed some sub-peritoneal hæmorrhages over the fundus of the bladder.

Spleen.—Much enlarged and very soft in consistence.

Brain.—Nothing abnormal.

Lymphatic Glands.—The left inguinal and iliac glands were slightly enlarged and discrete. There were some hæmorrhages around the iliac glands.

Films from the blood and spleen pulp showed a few plague bacilli and numerous streptococci. Films from the enlarged gland showed numerous plague bacilli.

S.J.

Case 129. *April* 21. *F., æt.* 68. *Duration of illness,* 24 *hours.*

All the organs were very much congested and in a decomposing state; they were also, especially the liver, full of air cavities. Heart showed old mitral disease. Liver not enlarged. Spleen not enlarged. Numerous hæmorrhages in the capsule. Hæmorrhage along the line of iliac vessels. Brain, like other organs, soft and congested. Smear preparations from blood in iliac vein, and also from spleen, showed numbers of bacilli corresponding to those of pestis bubonica with bi-polar staining, also proteus vulgaris.

S.J.

Case 132. *April* 22*nd.* *F., æt.* 17. *Duration of illness,* 96 *hours.*

Body well nourished. A few petechiæ about the legs. Large swellings on both sides behind and below the angles of the lower jaw.

Thorax.—Cavities: No gland or adhesions.

Lungs.—Over both pleural surfaces were a few subserous hæmorrhages. Both were slightly congested, but otherwise healthy.

Heart.—Muscle firm and pale. The right ventricle was filled by mixed clot. Valves and endocardium healthy.

Abdomen.—Peritoneum: Several small hæmorrhages seen beneath the peritoneum covering the lumbar portion of spine.

Liver.—Numerous small hæmorrhages on anterior surface of liver and over the fundus of the gall-bladder. Scattered through the substance of the liver were numerous small pin-point white masses closely resembling miliary tubercles. Some of these were surrounded by hæmorrhage.

Stomach and Intestines.—A few submucous hæmorrhages in the stomach.

Genito-urinary System.—Both kidneys were slightly enlarged and showed a few sub-capsular hæmorrhages. Cortex swollen and pale in both. Bladder and Ureters: Nil.

Uterus: Small. Tubes and ovaries congested, but no hæmorrhages around them.

Hæmopoietic System.—Spleen: Enlarged and softer than normal. On section of a dark reddish-brown colour.

Tonsils.—On the surfaces of both were sloughy patches, and on squeezing them a puriform fluid exuded from the crypts.

The lymphatic glands at the root of the mesentery below the pancreas were enlarged and softened and had hæmorrhage around them.

The glands on either side of the neck near the angle of the jaw were somewhat enlarged, softened, and mottled in appearance. They were absolutely embedded in a tissue composed of extravasated blood and inflamed cellular tissue. This appearance was visible along the entire course of both sterno-mastoid muscles.

Brain.

Brain.—Somewhat hyperæmic, but otherwise normal.

Microscopic examination of the blood, spleen pulp, and the juice of the enlarged cervical glands showed numerous plague bacilli.

The puriform fluid from the faucial tonsils was inoculated upon some sloped serum (solidified). In eighteen hours a copious growth took place, which was found to consist of rod-shaped organisms closely resembling the Bacillus Coli Communis. No Klebs Loeffler bacilli were found.

S.J.

Case 140. *April* 24. *M., æt.* 59. *Duration of illness,* 5 *days.*

Body rather obese. Small bruise over left eye. Numerous petechiæ on trunk and limbs. Rigor mortis and lividity well marked.

Thorax.—Lungs: Showed nothing unusual.

Heart.—Apparently healthy; full of pale yellow gelatinous clot on both sides.

Abdomen.—Peritoneum: Showed no petechiæ.

Liver.—Enlarged. Very fatty, and in an advanced stage of cirrhosis.

There were numerous hæmorrhagic points in the mucous coat of the gall-bladder.

Spleen.—Very large (about twice its normal size). On section it was found to be very soft and of a dark reddish-brown colour. Its trabeculæ were obscured.

Kidneys.—Both were enlarged; softer than normal. Numerous small sub-capsular hæmorrhages. Capsule was thin and non-adherent. The cortex was pale, swollen, and slightly mottled.

Lymphatic System.—No enlargement or sign of disease was found in any of the lymphatic glands.

A microscopic examination of the spleen pulp showed numerous typical plague bacilli present.

S.J.

Case 142. *April* 25. *M., æt.* 5. *Duration of illness,* 51 *hours.*

Body well nourished; skin pale, excepting slight *post-mortem* lividity on back. No enlarged glands. Hæmorrhage around the femoral, inguinal, and iliac glands on left side. Glands slightly inflamed. Lungs slightly œdematous, with a few petechiæ in pulmonary pleura. Liver slightly enlarged. Hæmorrhage into pancreas. Spleen normal in size and firmness. Splenic pulp dark red in colour. Heart contained dark and pale clots.

Piece of the spleen afterwards handed to Dr. Tidswell. G.H.T.

Case 143. *April* 25. *M., æt* 49. *Died in a Public-house bar. No information.*

A few petechiæ were present on the arms and legs. *Post-mortem* lividity and rigidity were both well marked.

Thorax.—The lungs showed nothing abnormal.

The heart showed nothing abnormal, except a few petechiæ on the visceral pericardium. It contained dark fluid blood.

Abdomen.—Peritoneum: There were numerous petechiæ upon the serous coats of the intestines.

Liver.—Somewhat enlarged and fatty.

Spleen.—Slightly enlarged; of firm consistence. On section of a dark reddish-brown colour.

The kidneys were swollen and pale. The cortices were somewhat swollen.

There was no evidence of enlargement of the lymphatic glands in any part of the body.

Microscopic films of the splenic pulp showed enormous numbers of plague bacilli.

S.J.

Case 173. *May* 3. *F., æt.* 56. *Duration of illness,* 9 *days.*

Body very obese. Face and neck much swollen, livid, and congested. *P.M.* lividity very marked.

Thorax.—Cavities: No hæmorrhages or fluid. Lungs: Engorged, but otherwise normal. Heart (13¾ oz.): Muscle pale; both ventricles and auricles contained a small amount of mixed clot.

Abdomen.—Peritoneum: Nil.

Liver.—Slightly enlarged, of soft consistence. Had a mottled appearance. No sub-capsular hæmorrhage. Liver evidently fatty.

Stomach and Intestines.—A few small submucous petechiæ in the stomach. Intestines were in places somewhat congested looking.

Genito-urinary System.—Both were enlarged and of rather soft consistence. On section they were dark and cyanotic. Cortex swollen. Capsule healthy.

Hæmopoietic System.—Spleen: Slightly enlarged; darker than normal; on section it was of about normal consistence and of a mahogany colour. Brain: Nil. Lymphatic Glands: In the right femoral region was an enlarged gland, about the size of a small hen's egg. The inguinal glands were also enlarged. The glands along the iliac vessels were also enlarged. All these glands were softened and somewhat mottled, and were surrounded by areas of extravasated blood.

Microscopic examination of the blood, spleen pulp, and the juice of the enlarged glands showed numerous plague bacilli.

S.J.

Case 184. *May* 2. *M., æt.* 59. *Duration of illness,* 75 *hours.*

Body well nourished. Rigor mortis universally present. *Post-mortem* lividity well marked. A few small petechiæ on legs and flanks. An enlarged gland could be felt in the left groin.

Thorax.—Lungs: Somewhat congested, but otherwise normal. Heart: Showed nothing abnormal. No ecchymoses in pleural or pericardial serous sacs.

Abdomen.—Liver: Slightly enlarged and mottled. A few petechial hæmorrhages found beneath the capsule of Glisson.

Spleen.—Enlarged; somewhat subnormal in consistence. On section the pulp was found to be softened and of a dark reddish-brown colour.

Kidneys.—Enlarged; capsule stripped readily; cortex pale and swollen.

Bladder and Ureter.—Healthy.

Stomach and Intestines.—Showed nothing abnormal, except that there were a few petechiæ in the mucous membrane of the stomach near its cardiac end.

Pancreas.—Nil.

The femoral group of glands in the left groin were enlarged, softened, and surrounded by hæmorrhage. On section they were mottled.

Microscopic films from the spleen and enlarged glands showed numerous plague bacilli.

S.J.

Case 197. *May* 6. *F., æt.* 5. *Duration of illness,* 48 *hours.*

Body was well nourished. A few petechiæ about the neck. On left side of neck, a little below the ear, I found a bubo about the size of a pigeon's egg. On cutting into this I found the gland surrounded by hæmorrhage, with œdema of the adjoining tissues. Slight œdema of the lungs, with numerous petechiæ in pulmonary pleura. Heart contained dark and soft pale clots. Liver soft and fatty. Hæmorrhage into pancreas. Small hæmorrhages on surface of liver, intestines, and kidneys. Spleen normal in size, not softened. Splenic pulp red in colour.

Death due to plague. This was afterwards confirmed by an examination of the spleen made by Dr. Tidswell.

G.H.T.

Case 198. *May* 7. *F., æt.* 65. *Duration of illness,* 6 *days.*

The body was that of a stout, well-nourished woman; skin was pale, excepting slight *post-mortem* lividity over the back; the face was placid. No enlarged glands. Lungs œdematous. Heart soft and fatty; dark and soft pale clots on both sides. Liver enlarged and fatty. Spleen much enlarged and soft. Splenic pulp very dark in colour. Kidneys cirrhotic. The femoral glands on right side were deeply congested, but not enlarged, and the tissues around them appeared to be normal. I dissected out the inguinal, axillary, and cervical glands, and found nothing abnormal. No trace of hæmorrhage, excepting a small patch, close to right ovary, which was bound down by old adhesions to the peritoneum; the hæmorrhage was beneath the peritoneum, and very dark in colour.

G.H.T.

Case 226. *May* 15. *M., æt.* 28. *Duration of illness,* 24 *hours.*

Well-nourished, muscular Chinaman. Body and face livid; hands clenched. Numerous petechiæ in neck and chest. Bubo about size of a hen's egg, a little behind and below the left ear, On cutting into this I found hæmorrhage surrounding the gland with œdema of the adjoining tissues. Lungs congested, and slightly œdematous. Small scattered hæmorrhages in pulmonary pleura, and pericardium; also on surface of heart. In the centre of several of these hæmorrhages there appeared to be a necrotic spot. The heart contained a quantity of imperfectly clotted dark blood. Numerous hæmorrhages on surface of liver and kidneys. Liver enlarged and fatty. Spleen slightly enlarged and soft, of a dark red colour.

G.H.T.

Case 234. *May* 18. *M., æt.* 20. *Duration of illness,* 7 *days.*

Body spare. Rigor mortis present, but not yet complete. Body still warm. Lividity marked. No petechiæ. Enlarged gland felt in left groin.

Thorax.—Lungs: Deeply engorged, but otherwise normal. Heart: Somewhat flabby, but otherwise not abnormal. Both sides filled with whitish-yellow gelatinous clot.

Abdomen.—Liver: Not enlarged. Numerous subcapsular hæmorrhages. Organ very soft and extensively fatty.

Spleen.—Very large (about twice normal size), of subnormal consistence. On section of a dark red colour. Pulp very soft. Trabeculæ obscured.

Kidneys.—Softer than normal. Cortex swollen and pale and speckled with numerous pin-point hæmorrhages. Capsule thin and non-adherent.

Lymphatic Glands.—One of the femoral glands on the left side was enlarged slightly and surrounded by sub-capsular hæmorrhage. On section it had a mottled appearance.

Films were made both of the spleen pulp and of the juice of the enlarged gland. In the former no plague bacilli were found, whereas the latter contained typical plague bacilli in great abundance.

S.J.

Case 238. *May* 19. *M., æt.* 70. *Duration of illness,* 48 *hours.*

Body well nourished. Rigor mortis and lividity both present, the latter excessive. A few small petechiæ about the size of pin-heads were scattered over the trunk and limbs.

Thorax.—Both lungs were the seat of a chronic interstitial pneumonia, the result of irritation from inhaled coal pigment. There were no petechiæ on the pleura. The bronchial mucous membrane was swollen and reddened, and the tubes contained a quantity of frothy muco-purulent matter.

The heart showed nothing abnormal, except that its right side was distended by pale yellowish gelatinous firmly adherent clot.

Abdomen.—Peritoneum healthy. Liver enlarged and mottled in patches. There were numerous hæmorrhages of small size into its capsule. Spleen enlarged, somewhat softer than usual. Its pulp was of a dark reddish-brown colour. The trabeculæ were obscured owing to the swelling of the pulp.

The kidneys were swollen and of soft consistence. These capsules stripped readily. Cortices were pale, somewhat mottled and swollen. On division of the capsule the kidney substance "lipped" over the divided capsule. The other organs in the abdomen showed nothing abnormal.

Lymphatic Glands.—One of the glands in the left femoral region was swollen, enlarged, and surrounded by a zone of hæmorrhage. On section it was soft and had a mottled appearance. The other glands showed nothing abnormal.

Microscopic examination was made of films from the spleen and enlarged gland, and large numbers of plague bacilli were found.

S.J.

Case 240.

Case 240. *May* 20. *M., æt* 45. *Duration of illness*, 12 *hours.*

Body very obese. A few petechiæ were found on the trunk and limbs.

Thorax.—Lungs somewhat engorged. Heart.—The walls of the heart, especially the left ventricle, were of soft consistence, and mottled from early fatty degeneration. The cavities of the organ contained a small quantity of dark fluid blood. Valves were healthy.

Abdomen.—Liver markedly enlarged, and the seat of extensive fatty degeneration. Spleen enlarged, of normal consistence. On section of a dark red colour. Trabeculæ obscured.

Kidneys somewhat enlarged and of soft consistence. On section the capsule stripped readily. The cortex was paler than usual and mottled throughout with numerous pin-point hæmorrhages. Stomach showed evidence of chronic gastric catarrh, and also numerous recent submucous hæmorrhages.

Lymphatic Glands.—In the right femoral region one of the glands was found to be swollen slightly, and to be surrounded by a small hæmorrhagic zone. On section it had a mottled appearance.

Microscopic examination of the spleen and lymphatic gland pulps showed numerous plague bacilli.
S.J.

Case 242. *May* 21. *M., æt* 17. *Duration of illness*, 12 *hours.*

External appearances.—A few petechiæ on sides of chest and on back. Rigor mortis present. Lividity marked. The glands in both inguino-femoral regions were felt to be enlarged and "shotty."

Thorax.—Lungs somewhat engorged. No sub-pleural hæmorrhages. Heart apparently healthy. A parti-coloured clot filled the right auricle and ventricle.

Abdomen.—Liver enlarged and slightly mottled. A few petechial hæmorrhages beneath the capsule of Glisson. In one small area in the substance of and on the surface of the organ was a group of small pin-point yellowish-white bodies closely resembling miliary tubercles. Spleen enlarged and almost semi-diffluent. On section it was of a dark reddish-brown colour.

Kidneys beyond being somewhat congested showed no abnormality.

Stomach.—The mucous membrane was swollen, red, mammillated, and at the cardiac end were numerous small submucous hæmorrhages.

Lymphatic Glands.—The glands in both inguino-femoral regions were found to be somewhat enlarged. In consistence they were harder than normal (resembling the condition seen in syphilitics). One of the femoral glands on the right side was somewhat redder than the rest, and on section were somewhat mottled.

Microscopic Examination.—Films were made, both of the spleen pulp and of the pulp of the gland described above. No organisms resembling the plague bacillus were found in the spleen, but the film taken from the gland contained innumerable plague bacilli. S.J.

Case 255. *May* 31. *M., æt* 55. *Duration of illness*, 15 *hours.*

The body was that of a muscular and well-nourished man; the face and neck deeply cyanosed; the mouth contained some semi-digested food. No enlarged glands. Old pleuritic adhesions in both sides of chest, the large bronchi inflamed, and the lungs somewhat congested. Heart large. Left ventricle hypertrophied; heart much diseased. Coronary vessels slightly atheromatous. Dark clots in both sides. Liver in an advanced stage of cirrhosis. Kidneys granular. Stomach contained a quantity of food; its mucous coat in a condition of chronic inflammation. Spleen enlarged; softer than normal. This appeared to be a recent change, and was a little suggestive of plague.

In the brain the arachnoid was thickened and opaque, with some atrophy of the convolutions.

A piece of the spleen was removed and handed to Dr. Tidswell, and, after examination, the case was reported as one of plague. G.H.T.

Case 295. *June* 29. *M., æt.* 55. *Duration of illness*, 70 *hours.*

Body very emaciated. A swelling about the size of a hen's egg in the right groin. Numerous petechiæ on the trunk and limbs. On the right leg were two small vesicular papulæ, which looked as though they had had their heads scratched off.

Thorax.—Both pleural sacs were entirely obliterated by old, tough, fibrous adhesions, the result of previous repeated attacks of pleurisy.

Lungs.—At the apices of both lungs were old deposits of chronic fibroid tubercle, and in the upper lobe of the right lung was a somewhat more recent spread of miliary tubercle. The bronchi showed signs of chronic catarrhal inflammation.

Heart.—There was considerable hypertrophy of the right ventricle. Both ventricles were distended by blood clot; that on the right side was for the most part of a yellowish-white colour, and slightly adherent to the columnæ carneæ. On the left side the clot was dark-coloured and very "crumbly." At the root of the aorta was some evidence of advanced atheroma; otherwise the heart showed no abnormality.

Abdomen.—There were no ecchymoses on the peritoneal covering of the intestines.

Liver.—Very soft and flabby, and of a pale yellow colour. On its surface were numerous small hæmorrhages beneath the capsule.

Spleen.—Enlarged; fairly firm in consistence, and of a dark reddish-brown colour.

Kidneys.—Both were enlarged and obviously congested. The cortex was swollen, and paler than normal.

Brain.—Nothing abnormal found.

The femoral and inguinal glands on the right side were enlarged and somewhat softened. They were surrounded by a small amount of hæmorrhagic extravasation. On section they were mottled in appearance. The glands along the line of the external and common iliac arteries on both sides were somewhat enlarged, and of a dark red colour.

Films of the blood, spleen, and enlarged lymphatic glands contained enormous numbers of plague bacilli. S.J.

APPENDIX E.

APPENDIX E.

Cases treated with Yersin-Roux Serum.

Table showing particulars of all cases admitted on and after May 13th (Case 217), when Serum first became availabl and distinguishing those (22) which did not receive it. The first 6 were admitted before May 13th, and wer treated merely because their cases were almost desperate. From Dr. Salter's clinical notes.

Consec. No.	Sex.	Age.	Day of illness on which admitted.	(1) Days of illness on which Serum was injected. (2) Quantity in Cub. Cents. (3) Place of injection (S. = Subcutaneously; V. = Intravenously).	Day after attack on which Patient—		Remarks.
					Was discharged.	Died.	
201	F	10	3rd	5/20 V	...	6th	Left cervical bubo; slight enlargement and tenderness of glan in both axillæ, and femoral gland on one side.
202	M	30	7th	9/20 V, 11/40 S, 12/20 S. 13/40 S, 15/20 V.	...	16th	Chinese; right inguinal bubo; steadily declined from attack
204	M	19	4th	7/40 S, 8/20 V, 9/20 V ...	...	11th	Septicaemic form; on 7th day right cervical gland becam slightly enlarged, and others at later dates.
205	M	28	3rd	7/40 S	...	8th	No buboes; right femoral gland and right axillary becam slightly enlarged on 3rd day.
208	F	16	3rd	8/20 V	42nd	...	Bubo, subpectoral on right side, and left cervical; afterward right femoral also.
216	F	29	3rd	3/20 S	97th	...	Bubo, left femoral; extreme lethargy on admission.
217	F	14	3rd	....	32nd	...	*No serum;* left femoral bubo; had a vesicular eruption cor considered to be chickenpox (which others in the family ha lately had); hæmorrhage occurred into each vesicle.
218	M	15	2nd	2/40 S, 3/20 V, 7/20 S, 8/20 V.	75th	...	Left femoral bubo; no other enlargement.
219	M	45	4th	....	56th	...	*No serum;* right femoral bubo; did not appear very ill o admission; T. 101, P. 92; T. fell to normal next day an never rose again.
220	F	23	4th	5/40 S	76th	...	Admitted 4th day; moderate attack.
221	F	15	5th	4/30 S	76th	..	Left femoral bubo only.
222	M	38	5th	5/40 S	76th	...	Some tenderness and indistinct swelling in both axillae; T 100, P. 80, on admission.
223	M	15	5th	....	41st	...	*No serum;* admitted 5th day; left inguinal bubo; T. 98·4, F 68, on admission; was never worse.
224	F	14	6th	6/40 S	53rd	...	Left femoral bubo; T. 99, P. 92, on admission; was neve worse.
225	M	16	2nd	2/40 S, 3/20 V, 4/20 S, 5/20 S.	42nd	...	On first day (evening) T. 103; P. dicrotic and very rapid lethargic; face pallid. On admission 2nd day, almost coma tose; T. 99·2.
226	M	28	......	.. ..	...	...	*Died before reception;* Chinese.
227	M	26	2nd	1/40 S, 2/40 S, 6/20 V, 7/30 S.	...	7th	Right axillary bubo; other glands slightly enlarged; deliriu and stupor at end of 1st day of illness; serum temporaril exhausted.
228	M	11	7th	7/20 S	35th	...	Notified 7th day; small right femoral bubo; a slight case.
229	M	43	1st	1/40 S	29th	...	Left femoral; did not appear to be very ill on admission.
230	M	20	......	3/40 S	...	3rd	Right inguinal; on discovery patient too ill to remove; die same day.
231	F	40	4th	3/30 S	80th	...	Left femoral only; a moderately severe case.
232	M	38	......	....	...	...	*Died before reception.*
233	F	35	5th	5/40 S	31st	...	Left femoral; a mild case.
234	M	20	.. ...	....	...	...	*Died before reception.*
235	M	46	6th	6/40 S	100th	...	A diabetic.
236	M	24	5th	....	52nd	...	*No serum;* supply threatened to run short temporarily patient hardly exhibited any constitutional symptoms o admission.
237	F	44	9th	....	34th	...	*No serum;* admitted 9th day, and showed no constitutiona symptoms.
238	M	70	......	....	...	...	*Died before reception.*
239	M	41	2nd	....	33rd	...	*No serum;* although the bubo was axillary, and patient ad mitted on 2nd day of illness, he offered very slight symptom of constitutional illness; he was said to have been ver delirious during the night which followed attack.
240	M	45	......	....	...	...	*Died before reception.*
241	M	4	......	.. ..	...	...	*Died before reception.*
242	M	17	......	....	...	...	*Died before reception.*
243	M	28	8th	8/40 S, 9/20 V, 11/40 S...	98th	...	Left cervical bubo; left sublingual gland enlarged and tender
244	M	26	5th	5/40 S	...	6th	23 hours in hospital; hopeless at admission. Chinese.
245	M	18	7th	....	42nd	...	*No serum;* right femoral; slight case; did well from admission
246	M	46	7th	7/40 S	...	8th	Right cervical; cough, and bright red sputum at first examin ation, 6th day of illness; bubo not observed till 6th day declined steadily from admission.
247	M	28	6th	....	32nd	...	*No serum;* right inguinal.
248	M	17	4th	4/40 S, 6/40 S, 7/40 S, 8/120 S.	...	10th	Septicæmic case.
249	M	38	3rd	....	42nd	...	*No serum;* supply short; showed no constitutional symptom except slight feverishness; other severe cases under treat ment.
250	F	13	3rd	3/75 S, 4/40 S	68th	...	A severe case.
251	M	23	4th	4/40 S, 5/80 S	...	5th	Right axillary, left axillary slightly enlarged and tender patient moribund; veins could not be entered.
252	M	74	12th	.. ..	45th	...	*No serum;* left femoral; practically convalescent on reception
253	M	6	6th	....	36th	...	*No serum;* right inguinal; P. 112 the only sign of illness o reception, when appetite very good.
254	F	26	2nd	2/30 S, 3/20 S, 5/20 S......	30th	...	Left femoral; a mild case.
255	M	55	......	....	...	...	*Died before reception.*
256	M	44	15th	/40 S	89th	...	Semi-conscious on reception; left femoral, inguinal; left axil lary; right and left cervical also enlarged; Chinese.

Consec. No.	Sex.	Age.	Day of illness on which admitted.	(1) Days of illness on which Serum was injected. (2) Quantity in Cub. Cents. (3) Place of injection (S. = Subcutaneously ; V. = Intravenously).	Day after attack on which Patient—		Remarks.
					Was discharged.	Died.	
257	M	33	3rd	3/40 S, and 20 V, 8/40 S	84th	..	Left inguinal ; a small carbuncle, abdomen, left side.
258	M	29	3rd	3/40 S, 4/20 V..............	30th	...	Large right cervical bubo.
259	M	9	2nd	1/17 S, 4/40 S	36th	...	Right inguinal ; right sterno-mastoid glands also tender.
260	M	7	2nd	2/50 S, 3/20 S	...	3rd	Right axillary, size of small orange ; 19 hours in hospital.
261	M	17	3rd	2/40 S, 3/20 V, 4/40 S ...	...	4th	No bubo ; carbuncle on back of neck ; 21 hours in hospital.
262	M	22	2nd	2/40 S	28th	...	Right axillary and right cervical.
263	M	68	6th	6/40 S	58th	...	Supra-trochlear, right ; also right axillary ; a slight case.
264	M	27	9th	7/40 S, 9/80 S, 20/40 S ...	60th	...	Right femoral and inguinal.
265	M	26	2nd	2/40 S, and 20 V............	39th	...	Left inguinal.
266	F	6	2nd	2/55 S, 3/40 S, 4/20 S, 5/60 S, 6/40 S.	...	6th	Right subpectoral.
267	F	44	3rd	3/40 S, and 20 V......	118th	...	Right femoral.
268	M	10	2nd	....	36th	...	*No serum* ; left femoral.
269	M	21	3rd	3/40 S	28th	...	Right inguinal ; a slight case.
270	M	5	5th	5/20 S	78th	...	Left cervical.
271	M	15	2nd	2/40 S and 40 V	34th	...	Left subpectoral.
272	F	13	6th	6/40 S	40th	...	Left inguinal ; very slight case.
273	M	41	8th	8/20 S	22nd	...	Right femoral ; ambulant case ; hardly ill on reception.
274	M	22	10th	10/40 S	36th	...	Right axillary ; a mild case.
275	M	50	......	4/40 S	...	4th	No bubo ; moribund on discovery.
276	M	20	19th	19/40 S	44th	...	Right femoral ; convalescent on reception.
277	M	32	5th	5/80 S	30th	...	Left axillary ; subsequently gland in right axilla became tender.
278	M	30	8th	....	33rd	...	*No serum ;* left inguinal ; very slightly ill on reception.
279	M	13	9th	9/40 S	49th	...	Left femoral ; convalescing on reception.
280	M	17	3rd	3/40 S and 20 V, 4/40 S, and 20 V, 6/40 S, 8/40 S, 16/40 S.	46th	...	No enlarged glands ; a severe case.
281	M	36	4th	4/40 S, and 40 V	43rd	...	An ambulant case ; right femoral bubo.
282	M	19	6th	6/40 S	105th	...	Right femoral ; an ambulant case ; had not lain up before reception.
283	M	19	5th	5/40 S, and 20 V...........	45th	...	Right femoral.
284	F	65	5th	5/80 S, 6/40 S	...	6th	Left subpectoral.
285	M	33	2nd	2/40 S	26th	...	Right femoral ; very slightly ill ; had not lain up before reception.
286	M	20	2nd	2/40 S, and 40 V...........	31st	...	Left femoral.
287	M	17	1st	1/40 S, and 40 V, 2/40 S, 10/40 S, 12/40 S.	44th	...	Right inguinal.
288	F	5	2nd	1/35 S	31st	...	Left axillary.
289	M	29	2nd	2/20 S	...	4th	Right femoral ; in hospital 11 hours ; hopeless when notified.
290	M	18	2nd	2/40 S	38th	...	Left femoral.
291	M	7	8th	8/37 S	38th	...	On reception, both inguinals.
292	M	38	5th	5/40 S, 7/40 S	46th	...	Left femoral ; at time of reception stock of serum had become temporarily exhausted.
293	F	38	5th	5/80 S	45th	...	Right femoral.
294	F	2	2nd	1/30 S, 4/20 S	34th	...	Left axillary.
295	M	55	......	....	...	...	*Died before reception.*
296	F	12	4th	4/20 S, 6/40 S	36th	...	Right cervical.
297	M	42	2nd	2/40 S, 3/40 S	40th	...	Right femoral.
298	M	22	6th	6/40 S and 40 V	33rd	...	Right axillary.
299	M	41	45th	45/60 S	78th	...	Right inguinal ; convalescent on reception.
300	M	45	21st	21/60 S, 27/40 S	60th	...	,, ,,
301	M	2	6th	6/20 S	36th	..	Right subpectoral.
302	M	56	5th	5/40 S	...	37th	Right axillary.
303	M	36	7th	7/40 S	58th	...	Left femoral ; this case was quite well marked, and approached the severe.

APPENDIX F.

Form 258.

Inoculation against Plague.—Second Series.

Department of Public Health, New South Wales, Sydney, 10 May, 1900.

IN view of the expected arrival of a further consignment of plague prophylactic, the Honorable the Premier and Colonial Treasurer has been pleased to approve of the following regulations for its distribution.

J. ASHBURTON THOMPSON,
President of the Board of Health.

Regulations.

1. Preference will be given to persons resident or employed within the infected area.
2. Application must be made by persons desiring to be inoculated at the Town Hall (Druitt-street entrance), between 9 a.m. and midday, on and after a day which will be announced.
3. Applicants will be furnished with a dated ticket entitling them to be inoculated on the date specified thereon.
4. Inoculations will be performed at the Town Hall (Druitt-street entrance) every day except Sunday from 1·30 p.m., until the supply of prophylactic has been exhausted. Two afternoons a week will be reserved for inoculation of women and children.

5. No person unprovided with a ticket will be inoculated. No person provided with a ticket will be inoculated on any but the date specified thereon. Should any holder of a dated ticket allow the appointed day to pass without appearing, a new ticket must be procured before inoculation will be done.

6. Managers of business establishments may furnish lists of their employees by letter, addressed to the Secretary, Department of Public Health, and endorsed "Inoculation." Dated tickets will then be posted to them in return. Employees may be divided by managers into batches, and request made that the different batches may be inoculated on different days.

7. Inoculation is gratuitous and voluntary.

Circular Letter to the Public.

Form No. 256.

Sir, Department of Public Health, N.S.W., Sydney, 1 May, 1900.

A further consignment of plague prophylactic being expected to arrive shortly, I have the honor to inform you that the following arrangement has been made for convenience of those managers of business establishments who may desire inoculation for themselves and their staffs.

2. On receipt of this letter a list of the persons employed at your establishment may be made out by you, and may be forwarded by post to me at the above address. As soon as the prophylactic has arrived you will then receive by post a ticket for each person named in your list, entitling him to inoculation on a date stamped thereon. You may find it convenient to divide your list, so as to avoid absence of your whole staff on one day, and if you do so it will be understood that you desire a different date to be appointed for inoculation of each division.

3. No inoculations will be done at this Department, and the place chosen will be duly announced in the newspapers.

I have, &c.,
C. A. SIMMS,
Secretary.

Letter to Heads of Departments of the Public Service.

Form No. 257.

Sir, Department of Public Health, N.S.W., Sydney, 1 May, 1900.

A fresh consignment of plague prophylactic being expected to arrive shortly, I have the honor, by direction of the President of the Board of Health, to inform you of the arrangements which have been made for inoculation of Civil Servants employed in Sydney.

2. Three methods will be available, and in accordance with regulations which the Premier and Colonial Treasurer has been pleased to make, the number inoculated on any one day will be strictly limited.

(*a*) If you have the goodness to furnish me with a list of the names of officers in your Department who desire to be inoculated, a portion of prophylactic will be forwarded to you sufficient for the number. You may then provide a medical man to make the inoculations, a room in which he can operate, and a clerk to record the names of those operated on, together with the date of operation. This list to be forwarded to me for record with reference to possible occurrence of cases of plague among the persons inoculated at some future date—a matter of great practical importance at this time.

(*b*) You may send a list of the names of members of your staff who desire inoculation to me, when you will receive tickets entitling the holder to be inoculated on a day specified thereon. The names may be divided into batches to be inoculated on different days (so as not to interfere with business unduly). The holders will then present themselves at the place of public inoculation on the appointed day, and will take their turn with the general public.

(*c*) Individuals may make personal application at the place which will be appointed for the issue of tickets, when they will receive dated tickets as last mentioned.

3. Should you decide to adopt either of the methods (*a*) or (*b*), I am to ask you to be good enough to communicate with me at the earliest possible date. It is particularly requested that the names of gentlemen who are habitually employed in Sydney may alone be mentioned, others being in no known danger, and the supply of prophylactic being limited. The place at which tickets will be issued, and the place of public inoculation, will be announced in due course in the newspapers.

I have, &c.,
C. A. SIMMS,
Secretary.

Form No. 268.

Department of Public Health, N.S.W.

Sir, Sydney,

In answer to your recent request, I have the honor, by direction of the Chief Medical Officer of the Government, to forward you herewith doses of Haffkine's plague prophylactic, and to call your attention to the instructions and conditions mentioned hereunder.

As a matter of convenience the form referred to, which will be found overleaf, is perforated, so that it may, when filled up with the particulars, be torn off and returned to me.

I have, &c.,
C. A. SIMMS,
Secretary.

To Dr.

Haffkine's

Haffkine's Prophylactic.

The prophylactic is issued to medical practitioners on condition that they forward to the Secretary of this Department, as soon as possible, particulars concerning ages, addresses, and doses administered, &c., by them, in accordance with subjoined form :—

Dosage.

For a male aged 25 years or over	5cc.
,, ,, ,, 20 ,, ,, ...	4cc.
,, ,, ,, 15 ,, ,, ...	3cc.
,, ,, ,, 10 ,, ,, ...	2cc.
,, ,, ,, 5 ,, ,, ...	1cc.

Intermediate ages, intermediate doses. Females to receive one-fifth less than males of same age.

Note.—It is not safe to use the prophylactic save within an hour or two after the bottle has been opened. Arrangements should be made for the attendance at the same time of a sufficient number of people to use up the whole bottle.

Schedule.

Particulars of Persons inoculated with Haffkine's Prophylactic.

Date of Inoculation.	Name.	Age.	Address.	Dose.

(Signed)

(Address)

The Secretary, Department of Public Health, Sydney.

APPENDIX G.

Cleansed Areas.

Table showing the dates on which Cases were infected within the several Areas which were specially cleansed, before, during, and after completion of cleansing : together with the dates on which each area was closed for cleansing. The dates of release are often merely formal ; areas seldom remained closed more than seven or eight days, and often less. (*See* Diagrams A, B, and C.)

	Case No.	Date.		Case No.	Date.
		1900.			1900.
Area 1.—Subdivision 1	5	March 1	Area 2.—Subdivisions 1 and 2	56	March 30
	11	,, 5		70	April 1
	14	,, 10		Closed ...	,, 2
	19	,, 13		Released	,, 6
	21	,, 14	Subdivision 3	9	March 7
	24	,, 18		67	,, 31
	25	,, 18		Closed ...	April 2
	26	,, 15		83	,, 5
	32	,, 20		84	,, 5
	Closed ...	,, 23		85	,, 5
	37	,, 25		Released	,, 10
	Released	,, 31	Subdivisions 4 and 5	Closed ...	,, 2
	104	April 4	Subdivision 4	Released	,, 12
	165	,, 30	Subdivision 5	,,	May 22
Subdivision 2	2	Feb. 18	Subdivision 6	49	March 26
	Closed ...	March 23		55	,, 28
	39	,, 25		58	,, 26
	Released	April 3		64	,, 29
				65	,, 29
Subdivision 3	Closed ...	March 23		66	,, 29
	Released	May 22		Closed ...	April 2
				Released	June 4
Subdivision 4	10	March 7	Area 3.—Subdivision 1	29	March 20
	Closed ...	,, 23		Closed ...	April 9
	97	April 6		Released	,, 12
	103	,, 10	Subdivision 2	27	March 17
	Released	May 22		Closed ...	April 9
Subdivisions 5 and 6	Closed ...	March 23		Released	May 22
Subdivision 5	Released	May 22	Subdivision 3	Closed ...	April 9
Subdivision 6	,,	,, 22		Released	June 27

	Case No.	Date.	
		1900.	
Area 4	Closed ...	April	9
	Released	,,	20
Area 5.—Subdivision 1	53	March	29
	100	April	6
	Closed ...	,,	12
	140	,,	19
	Released	,,	20
Subdivision 2	52	March	25
	75	April	2
	86	,,	5
	107	,,	12
	Closed ...	,,	12
	Released	,,	24
	189	May	3
	223	,,	10
	255	,,	31
	285	June	22
Area 6	Closed ...	April	20
	Released	,,	24
Area 7	8	March	6
	110	April	10
	Closed ...	,,	20
	173	,,	25
	Released	May	1
Area 8	61	March	29
	62	,,	31
	Closed ...	April	24
	Released	May	25
Area 9	34	March	21
	183	April	25
	Closed ...	,,	27
	Released	May	1
Area 10	89	April	7
	Closed ..	,,	30
	Released	May	15
	290	June	24
Areas 11 and 12	Closed ...	May	1
	Released	,,	15
Area 13	57	March	26
	Closed ...	May	2
	Released	,,	15
Area 14 (Redfern)	23	March	17
	59	,,	30
	77	April	5
	80	,,	3
	134	,,	21
	159	,,	23
	177	,,	29
	Closed ...	May	3
	Released	,,	15
Areas 15 and 16	Closed ...	May	5
	Released	,,	15
Area 17	Closed ...	,,	7
	224	,,	9
	Released	,,	22
Area 18	129	April	20
	Closed ...	May	15
	245	,,	17
	Released	June	1
	297	,,	29
Area 19	72	March	31
	Closed ...	May	15
	Released	June	1
Areas 20 and 21	Closed ...	May	15
	Released	June	1
Area 22	4	Feb.	26
	Closed ...	May	15
	Released	June	1
	303	August	2
Area 23	Closed ...	May	15
	Released	June	1
Area 24	234	May	11
	Closed ...	June	1
	Released	July	3
Area 25	230	May	14
	258	,,	29
	Closed ...	June	1
	Released	,,	15
Area 26	Nil.......	Nil..........	
Area 27 (Paddington)	76	April	4
	121	,,	16
	151	,,	21
	154	,,	25
	167	,,	23
	208	May	8
	Closed ...	June	7
	Released	July	3
Area 28 (Paddington)	Closed ...	June	7
	283	,,	17
	284	,,	18
	Released	July	3
Area 29	233	May	13
	Closed ...	June	15
	295	,,	26
	Released	July	10
Area 30	127	April	20
	231	May	13
	Closed ...	June	15
	Released	July	10
Area 31	212	May	11
	Closed ...	June	15
	Released	July	10
Area 32	94	April	6
	123	,,	18
	176	,,	26
	Closed ...	June	15
	Released	July	10
Area 33	116	April	11
	136	,,	22
	172	,,	30
	Closed ...	June	15
	Released	July	10
Area 34 (Waterloo)	161	April	28
	162	,,	28
	170	May	2
	237	,,	10
	Closed ...	June	15
	Released	July	10
Area 35	190	May	1
	266	June	3
	Closed ...	,,	15
	Released	July	10
Area 36	35	March	25
	111	April	11
	160	,,	26
	235	May	13
	254	,,	29
	263	,,	28
	Closed ...	July	17
	Released	August	5
Area 1 (Manly)	175	May	2
	213	,,	11
	217	,,	13
	242	,,	21
	253	,,	29
	257	June	1
	Closed ...	,,	4
	288	,,	25
	Released	July	3
Areas 2 and 3 (Manly)	Closed ...	June	26
	298	July	12
	Released	,,	13
Areas 5 and 6 (Manly)	Closed ...	,,	10
	Released	,,	13

APPENDIX H.

Text of the Poster and Pamphlet issued on March 1st, 1900.

Department of Public Health, New South Wales.

Prevention of Plague.

Plague is present in Sydney. It has been introduced by diseased rats, and there is great danger of its spreading still further.

Great efforts must therefore be at once made by Municipal Councils and by individual householders to kill all rats. This war must be persistently and steadily carried on. It must extend to every neighbourhood, as well as to those where the rats are known to be infected, for the following reason :—As soon as rats find they are dying in numbers, or are being trapped and killed, in any place they inhabit, they leave that place and go to some other. If there are already rats at the latter place, these become infected by the immigrants, and then disperse in their turn, thus carrying the disease still further. All rats, therefore, must be exterminated as far possible, and the attack upon them should be simultaneous in the healthy and infected neighbourhoods.

The following hints should be carefully read :—

1. It is most necessary that rats should be kept out of dwellings. Take care that doors are not broken near the ground, and close them at night ; see that all gullies are effectually trapped ; see that every house connected with the sewers is so connected according to the Regulations of the Board of Water Supply and Sewerage, and that the traps are in good order, so that rats cannot get past them.

2. Gather up with scrupulous care all fragments of food, bones, vegetables, potato-peelings, corn, &c., &c., and either burn them at once behind the kitchen fire, or place them in a securely covered dirtbox ; as far as possible also leave no water about where rats can get at it. Rats are always looking for food, and will not stay where none is to be found.

3. Lastly, take measures to kill any rats which happen to reach the premises. Poison is the best means, and nothing is better than arsenic, which is sold as "Rough on Rats," and under other names. It should never be spread on bread and butter, which might attract children, nor on any similar food. It should be mixed with a little meal and water. Oil of aniseed and an oil called oil of rhodium are said to be specially attractive to rats, and a little may be mixed with the meal, or smeared on traps. Set traps also. Use dogs too ; dogs very rarely indeed have suffered from plague, and, at all events, it is not only diseased rats which are to be destroyed, but also healthy ones.

Dead rats found about premises should not be touched until they have first been scalded with boiling-water where they lie ; they should then not be taken up in the hands but with tongs ; they should be burnt.

Extermination of rats is the most important thing to be attempted at this time. Very good reason has been shown for thinking that the plague spread in Indian cities not so much in proportion to overcrowding nor to filth as in proportion to the facilities which houses afforded by their construction for entrance of rats to dwelling-rooms.

Still, it must be remembered that, although rats may begin an epidemic of plague in man, they are by no means the only carriers of the contagion. Plague is a fever ; like other fevers, it is aided in its attacks by filthy surroundings, and probably its infection is fostered by filthy heaps of neglected and putrefying material, and by filthy earth.

Very great and special pains must therefore be taken by householders to thoroughly cleanse their houses internally, their yards, their gutters, and their drains. Municipal authorities should increase their staff of scavengers, and take care that all the minor nuisances (which at present are subject of daily complaint to this Department) are abated forthwith, and prevented from recurring ; they should also regularly collect and destroy filth, sweep and flush road and other gutters under their control, and take care that sewers within their jurisdiction are often flushed. Municipal authorities are seldom provided with large staffs, and nuisances sometimes exist for long before they are detected and dealt with. Every ratepayer should make a point, therefore, of reporting every nuisance which he observes in his district to the Council Clerk, who represents the Council, which latter is the Local Authority under the Public Health Act for the district it serves. It has full legal power to deal with and prevent all nuisances, either by its own action or through the Police Courts. Such complaints should not be addressed to this Department, which cannot execute detail work over the whole Colony. Detail work is the duty of Local Authorities within their several districts or municipalities.

Directions for Special Cleansing and Disinfecting.

Limewash all ceilings and whitened walls afresh ; limewash all cellar, basement, and outhouse walls.

Swab all woodwork thoroughly with carbolic water—include sash frames, window cases, &c.

Remove all floor coverings ; have carpets beaten ; oilcloth, &c., to be washed with carbolic water on both sides. Scrub the floors if of boards, and swab with carbolic water. Water stone, brick, and earth floorings with carbolic water three times a week.

All lumber and the like not in actual use must be removed from the premises and not returned to them. All wastes, garbage, ashes, dung, stable bedding, &c., &c., must be removed, and stable bedding renewed with clean stuff.

Stable floors, if of wood, or likely to be foul beneath, must be torn up, the surface below thoroughly cleansed as described, and replaced with good floors properly close-jointed and caulked, well-bedded on a sound bottom, and graded to a gutter. The gutter must be placed in communication with a gulley leading to the sewer.

All drains, gullies, sinks, water-closets must first be flushed with hot water. They must then be flushed with carbolic water, and afterwards be kept dressed with chloride of lime.

Furniture must be moved so as to give access to walls for cleansing, &c., and to the floor on which it has been standing.

All makeshift buildings and and sheds in bad repair must be pulled down and removed before the premises can be considered clean.

Solid disinfectant—Chloride of lime.
Liquid disinfectants—Carbolic water—Miscible carbolic, ¾ pint; water, 1 gallon.
Carbolic limewhite—Miscible carbolic, ½ pint to the gallon.

For household use, chloride of lime, mixed with water in the proportion of half a pound to the gallon, may be used for all purposes within and outside; or carbolic acid and the well-known tarry disinfectants, suitably diluted according to instructions with which they are sold. The poorer inhabitants should be supplied by the Local Authority for the district (the Municipal Council) free of cost, and Sanitary Inspectors should see that the disinfectant is properly applied.

The fullest information as to disinfection and disinfectants has been printed in a pamphlet, containing Suggestions for the prevention of the Infectious Diseases proclaimed under the Public Health Act, of which large numbers of copies have been sent to each Local Authority over the whole country. This was done more than a year ago. Any ratepayer can get one by application at the Council Chambers in his district.

By order,
C. A. SIMMS,
Secretary.

Sydney, 1st March, 1900.

⁂ Local Authorities will be supplied gratis with the disinfectants called miscible carbolic acid, cresylene, and chloride of lime, on application to the Chief Inspector of Stores, Young-street, Sydney; but of the two first named one only will be furnished.

APPENDIX I.

Form No. 251.

Department of Public Health, New South Wales.

Prevention of Plague.

Notice to Shipmasters, Agents, and Owners touching fumigation and destruction of rats.

All vessels trading between Sydney and every other port or place in New South Wales having to be fumigated under the Proclamation No. 286 of Friday, 30th March, 1900, in accordance with the requirements of the Board of Health, and having to produce a certificate that such fumigation has been so done to the Customs Officer at the ports or places at which they touch before communication with the shore will be permitted them, the following suggestions are published with a view to prevent loss of time in performing fumigation:—

1. Masters are expected to assist the officers of the Board in every way.
2. Preparation for fumigation should be made by the Masters as follows:—Compartments to be carefully examined and all openings closed, except one for access, as well as all cracks and crevices, A bucket of paste and a bundle of old newspapers are all that is required besides the usual closings, hatches, &c., &c.
3. As soon as these preparations are complete or well under way, notice must be given to Captain Tait, Superintendent of Fumigation, at the Customs House, Circular Quay, stating where the vessel is lying, and when she will be ready for fumigation to begin. The Superintendent will supply forms on application.
4. The actual fumigation must be done by or under immediate superintendence of the appointed officers of the Board.
5. After completion of fumigation to the satisfaction of the Superintendent, a certificate will be given in the appointed form, stating that fumigation has been done, and that the certificate is good until the date mentioned therein, when it will expire, and when fumigation must be repeated.

By Order,
C. A. SIMMS,
Secretary.

Sydney, 30 March, 1900.

Form 243.

Certificate of Fumigation delivered to Master by Superintendent.

Department of Public Health, New South Wales.

This is to certify that the vessel Master, tons register, was fumigated at this port for the purpose of destroying rats on board, under supervision of an officer of this Department, on this day of 1900.

C. A. SIMMS,
Secretary.

Signed, Superintendent.

1900.

Note.—This certificate is incomplete and of no avail unless countersigned by the Superintending Officer

APPENDIX K.

APPENDIX K.

Governor's Regulations under the "Wharfage and Tonnage Rates Act of 1880."

1. Every vessel lying at a public wharf at any port or place in New South Wales must be maintained by fenders at a distance of not less than 4 feet from the wharf.

2. The fenders used, as required by the last preceding Regulation, together with any ropes attached to them must be freshly tarred each time before use, and daily if continuously used for more than twenty-four hours.

3. To each hawser and rope by which the vessel is made fast for 6 feet of length from the shore end, and for 6 feet in length from the ship end, and to fore and aft springs throughout their whole length, tar must be applied so that the said parts and springs are thoroughly covered, freshly before each time of use and daily if continuously used for more than twenty-four hours. The tar may be applied by means of bagging securely fastened around the hawser, rope, or spring.

4. All gangways must be drawn up, except when in actual use, for reception of cargo, except a single passenger gangway, and the said passenger gangway while in use must be constantly maintained freshly tarred on its upper surface for a distance of 3 feet at least from its shore end, and for a distance of 3 feet at least from its ship end.

5. Between sunset and sunrise, lamps of the best available sort must be suspended over the side sufficient to keep the wharf fore and aft brightly lighted.

6. All port and other holes in the ship's side next the wharf must be kept closed, unless in actual use for reception of cargo, when they must be brightly lighted as long as the vessel lies at the wharf.

7. No net must be used between the ship and the wharf.

8. No lighter must be allowed alongside except by special written permission of the Manager of Public Wharves.

9. Every master of a vessel who contravenes any of these Regulations shall be liable to a penalty not exceeding £20, and not less than £5, which may be recovered in a summary way before a Police or Stipendiary Magistrate, or any two Justices of the Peace, in accordance with the Acts relating to proceedings before Justices of the Peace, adopted by the Act 14 Vic. No. 43, and any Acts amending the same.

APPENDIX L.

Report of the Board of Health upon the Case of A.P.

The Chief Medical Officer of the Government and President of the Board of Health to The Honorable the Premier and Colonial Treasurer.

February 7, 1900.

* * * * * * * * * * *

I.—CLINICAL ACCOUNT.

A.P., aged 33, married, a rather slight but muscular man, fair, and of nervous temperament; had had no illness for several years past. On *January 19th* he was driving a lorry through the city about 12 o'clock, on a very hot day, when he was suddenly seized with giddiness, headache at the vertex, and pain in the region of the stomach; he was obliged to lie down for a time when he reached the warehouse to which he was then going, but afterwards finished his day's work, though still suffering. About four hours after attack he began to feel pain in the left thigh near the groin, and discovered a small lump which had not been there before. He left work at 6 o'clock and went to bed; he took some castor oil, and had free action of the bowels; he also vomited, the vomit being of natural appearance. He was very ill all night with headache, thirst, fever, and continued pain in the gastric region; the lump in the thigh ached continuously. *January 20th*, at 2·15 p.m., he was found dozing, but was easily roused to attention; his face was flushed, and a little puffy or heavy-looking; his eyes were slightly suffused; the skin felt burning hot, the axillary temperature was 104·9° F., and the pulse was rapid and bounding. Examination of the lungs discovered no sign of disease; he was able to move about the bed freely, and to show various parts of his body readily; he answered questions promptly and clearly; there was no delirium, nor anxiety, nor interference with speech; the spleen could not be felt. The left lower extremity showed the lowest gland of the femoral chain enlarged; it was just visible, was about the size of an unshelled almond, indurated, and but slightly tender on pressure; the swelling was well defined, and limited to the gland itself, there being no infiltration of the surrounding tissues; two other glands, which seemed not to be enlarged, could be distinguished just above it. There was no inguinal enlargement, and careful examination of the rest of the body failed to discover any other swollen ganglion, except one in the right submaxillary region; this was hard, was not tender, and, though the patient was unaware of it, was probably old. The genital organs were perfectly free from lesions of any kind, and there were no signs of venereal disease present or past. The leg was examined for injuries which might have given rise to swelling of the gland, but none were found. A further examination, made two days later, disclosed the following:—Behind the left external malleolus, and just anterior to the edge of the achilles tendon, was a circular spot, about 3 mm. in diameter; the cutis was purplish red; the cuticle which had been detached was then adherent to the skin; at one point of the circumference it was slightly ragged. It seemed probable that this had been a bleb; its circular form and protected position suggested that it had not been produced by abrasion; and, while the feet showed no evidence of chafing at any other point, the patient said he had been wearing the same boots for three or four months past, and that they had never hurt him. Three days afterwards the cutis had lost its reddish-purple colour, and new cuticle had been formed. Earlier observers felt unable to say that this lesion had not been present at the first examination.

On *January 21st* his temperature had fallen to 102·2° F.; the pulse was no longer bounding, and was occasionally intermittent (imperfect systole); he still had some headache at the vertex, but he had slept tolerably well, and was better. The gland formed a visible lump of the size of a walnut; the skin over it was slightly red, but it had been continuously fomented with hot boracic lotion ; there was commencing peri-adenitic effusion, but no matting with the smaller glands immediately above could be made out. On *January 22nd* his temperature about midday had fallen to 99·2° F. ; he was cheerful and alert, but pale and rather tremulous ; the headache was less ; he felt weak, but not exhausted ; the gland had markedly increased in superficies, but was not much thickened, and though still quite tender was not at all acutely sensitive. He had slept well. On *January 23rd* the patient was in a similar state, but decidedly thinner and paler than at first ; his temperature had risen again to 102·4° F. ; the pulse was weak and easily compressed, but not intermittent. The femoral swelling had increased, and was nearly circular, about 2 inches in diameter. On *January 24th* his temperature was still 102·4° F., and his general state about the same ; the femoral gland was of the size of a mandarin orange ; it was still hard, surrounded with effusion, only moderately tender, and free from fluctuation.

2.—Bacteriological Investigation.

The bacteriology of this case was described by Dr. Frank Tidswell in the following report :—

On January 21st a puncture of the gland was made with instruments just previously sterilised by exposure to steam for half an hour in the Koch steriliser. The cotton-wool wrappings were retained till the time of operation, and the instruments were still warm when used. The part had been continuously treated with boracic acid fomentations for the previous twenty-four hours. Just prior to the operation the skin was shaved, well washed with 5 per cent. carbolic lotion, then with recently boiled and still warm distilled water, and finally dried with sterilised cotton wool. Through the single opening in the skin by partial withdrawal the syringe needle was passed in six different directions through the gland. The piston was raised on each occasion, but no fluid entered the barrel of the syringe. On its final removal the channel of the needle was found to contain a minute quantity of blood. This was ejected over the surface of a serum culture tube brought for the purpose, and a second serum culture tube was inoculated from the first in the ordinary way by means of the platinum needle. Both of these tubes incubated at 37° C. remained sterile for a period of ten days, when their further observation was abandoned.

On January 22nd, whilst palpating the gland, a drop of pus-like fluid was expressed through the puncture hole of the previous day. On the 23rd and 24th also similar fluid was obtained in the same way. On each occasion the single drop issuing was used to make smear preparations, and cultivations on serum and agar ; and that obtained on the 22nd was also used to inoculate a mouse. As the microscopical and cultural characters of the three samples of fluid were identical, one description will serve for all.

The fluid expressed was of a dark greyish colour, showing a little red (blood), but no yellow. A small portion set aside was found to have clotted firmly when examined half an hour afterwards. The amount of blood present was far too small to account for this clotting, and, moreover, the clot was pale in colour. It is evident, therefore, that the fluid contained a large admixture of lymph. Under the microscope the fluid was seen to contain numerous lymph cells. A few were normal in character, but most of them showed fragmented nuclei, and more or less granular cytoplasm, *i.e.*, resembled "pus cells." Lying in groups and singly amongst the cells were numerous bacilli, varying, but commonly ovoid or cylindrical in form, ranging between 1μ and 3μ in length and about $·5\mu$ broad ; ends tapering and finally rounded off ; staining well with gentian violet, fuchsine, or methylene blue, and more densely at the poles than in the middle of the rods. The majority did not retain the stain when treated by Gram's method, although here and there an individual bacillus remained coloured. No spores were seen. Rounded bacterial elements were not uncommon, and the results of cultivation subsequently showed them to be micrococci, and not merely cocco bacilli.

The cultivations were upon ordinary serum and upon nutrient agar, the inoculations being made at the bedside with the platinum needle sterilised in the flame of a spirit-lamp. The tubes, inoculated about noon, showed definite growth on the second morning afterwards, *i.e.*, in about forty-five hours, having been incubated at 37° C. in the interval. The growths were of two kinds, one composed of micrococci, the other of bacilli.

The micrococcal growth upon serum developed in the form of rounded colonies, attaining a diameter of ·5 mm. in forty-eight hours, and extending to 2 or 3 mm. in three or four days. Thick, opaque, flat, slightly irregular margins, smooth surface, creamy white in colour. In subculture the growth was more rapid at first, a 1 mm. wide creamy streak developing in twenty-four hours. After this the growth extended slowly, reaching a width of about 3 mm. after five days at 37° C. No alteration in colour was observed. There was a thick deposit and turbidity in the condensation water. Upon nutrient agar the growth was similar to that on serum, but whiter. On glucose agar the growth was more abundant than on nutrient agar, and was well up in twenty-four hours. In bouillon there was uniform turbidity already apparent in twenty-four hours.

The cocci stained readily with gentian violet, fuchsine or methylene blue, and retained the colour when treated by Gram's method. Under the microscope they were seen to be regular in outline, and to lie singly or in groups (staphylo cocci). There were no chains. Individual cocci measured ·5 to $·8\ \mu$. in diameter. The transverse line commonly seen in the pyogenic cocci was not detected in any of the specimens examined.

The bacilliary growth upon serum at 37° C. was scanty. It appeared in forty-eight hours in the form of small, round, slightly raised translucent colonies, of a little less than ·5 mm. in diameter. The growth had not extended much by the third day, after which, in the original tubes, it became overgrown by more rapidly developing micrococci. In subculture upon serum the growth was visible as a thin colourless streak, in forty-eight hours it increased to a band about a millimetre wide. After five days it formed a thin translucent streak still limited to the neighbourhood of the inoculation line, slightly thicker at the margins with outlying colonies, and showing granular raised specks at irregular intervals. Upon nutrient agar and glucose the growth was very similar, and when looked at from the back had a ground-glass appearance. In broth it formed abundant spicular or crumb-like particles attached to the side of the tube, with an obvious deposit of same character as that in Haffkine's prophylactic, the broth itself remaining perfectly clear and transparent. A filmy appearance on the surface disappeared on shaking, and was not reformed after four days at 37° C. In flasks with oil a film and a few pendent growths 2 to 6 mm. long were formed, as well as a copious deposit.

The bacillus stained readily with violet, fuchsine, or methylene blue. Is decolourised by Gram's method, although here and there individual bacilli or small groups of them retain the colour. Non-mobile, at least as regards obvious movements of translation. The bacillus shows very distinct bipolar staining, more marked in some specimens than in others, but clearly recognisable in all. This characteristic may amount to the colouration of only a polar granule, or to colouration of most of the bacillus, leaving only the middle of the rod unstained. Intermediate gradations are common. The bacillus varies very much in form, regularly cylindrical, boat-shaped, club-shaped, dumb-bell, and oval elements are the commonest forms. The length varies between $1\ \mu$ and $3\ \mu$, and the breadth is usually about $·5\ \mu$. The ends are rounded off. No spores were observed.

Some of the material obtained from the femoral swelling on 22nd January was inoculated at 4·30 p.m. into a mouse—into the back at the root of the tail. The animal was lively during all the next day. There was no visible swelling at the site of inoculation ; but the mouse was not handled. Next day it was much less lively in the morning, and got very sick during the afternoon. At 6 p.m. it was huddled up, coat rough, respiration hurried, refusing food, but started up when the glass of its jar was flicked. It was found dead and stiff next morning at 9 a.m., having thus become definitely sick within forty-eight hours, and died within sixty-four hours after inoculation.

The principal *post-mortem* features were as follows : Hæmorrhagic œdema at site of inoculation ; enlargement of the inguino-femoral glands on the right side ; no enlargement of glands detected elsewhere ; pericardium dusky, but no hæmorrhages seen ; both ventricles of the heart distended with feebly clotted blood ; lungs bright red in colour, patchy pneumonia (?) ; liver definitely but not very much swollen, mottled white and pink on surface ; deep red on section ; gall bladder empty, or nearly so ; spleen not much, if at all, longer than normal, but thicker, swollen in such a way as to lose its normal sharp edges and assume a sausage-shaped form, section deep red, trabeculæ could not be seen with a hand lens ; stomach normal, small intestine congested, large intestines not obviously affected, but contain fluid fæces ; kidneys mottled, ection pale, internal structure obscure ; bladder distended with urine of normal colour. Smear preparations and cultures made from various organs gave the bacilli showing bipolar staining.

A second mouse, inoculated with a small piece of the spleen of mouse 1 on 25th January, at 10·30 p.m., was lively on the following day (26th). On the 27th it became sick, exhibiting the same symptoms as the first mouse. On the 28th, at 9 a.m., it was lying partly upon its left side—the hind quarters being in a normal position; but the forelegs were tucked away, the left shoulder touching the wire-gauge floor of the cage, and the head stretched out. It remained quiescent in this position till it died at 11 o'clock. The second mouse thus became sick in about forty-eight hours, and died in seventy-two and a half hours after inoculation.

The principal *post-mortem* features were as follows, the animal being examined ten minutes after death: Hæmorrhagic œdema at the site of inoculation; enlargement of hæmorrhagic infiltration round the right inguino-femoral glands; enlargement of the left inguino-femoral, and right and left axillary glands, but no hæmorrhage. Pericardium dusky, but no hæmorrhages; right ventricle of heart contains fluid blood, left ventricle contracted and empty; lungs redder than normal, but not so much affected as in first mouse; liver slightly swollen, mottled pink and white on surface, section deep red; gall bladder distended with clear yellow bile; spleen not visibly altered internally, but section a little thicker than normal, and of a deep red colour; trebeculæ faintly discernible with lens; stomach normal, small intestines markedly congested, large intestine contains fluid fæces; kidneys normal on surface; section pale; structure obscure; bladder empty. Smear preparations and cultures were made from various organs gave bacilli as in first mouse.

A third mouse, inoculated on 28th instant with a small piece of the spleen of mouse No. 2, became sick on the 30th instant. During 31st January and 2nd February it had a series of seizures, characterised by very hurried and laboured breathing and prostration, and on each occasion appeared about to die. In the intervals it sat quietly huddled up, rarely moving, and taking very little food. It was found dead at 9 a.m. on the morning of 2nd February, having thus become sick on the second day, and died in about four and a half days. The *post-mortem* appearances were very similar to those shown by the other mice; in particular, the left inguino-femoral glands were swollen and surrounded by hæmorrhagic œdema, and the spleen enlarged to twice its normal size.

A guinea-pig, inoculated in left thigh on 25th January with a small piece of the spleen of mouse 1, showed no sign of illness till the 27th, but upon that day became quiet and drowsy, and took food sparingly. On the 28th it became very obviously sick, sitting huddled up with the back arched, eyes partly closed, and rarely moving. On the 29th and 30th it remained in very much the same condition, and was found dead at 9 a.m. on the 31st instant. The principal *post-mortem* features were as follow:—Hæmorrhagic infiltration at site of inoculation and in left inguino-femoral region; right groin normal; enlargement of and hæmorrhage round left axillary glands; right axillary glands enlarged; heart shows subpericardial hæmorrhages along auriculo-ventricular and interventricular grooves, and also along the edge of the right ventricle; lungs dark in colour, especially upper and middle right lobes, in which there is broncho-pneumonic consolidation; subpleural hæmorrhages in various places in all lobes; liver enlarged to about twice normal size, mottled red and white on surface, numerous small subcapsular hæmorrhages; spleen about three times larger than normal, deep violet in colour, showing very numerous white areas on both sides resembling miliary tubercle in appearance, edges rounded, no hæmorrhages; kidneys not enlarged, dusky in colour, hæmorrhages under capsule; suprarenals, especially left, enlarged and hæmorrhagic; bladder distended with clear urine giving albumin ring with nitric acid. No definitely abnormal appearances were detected in stomach or intestines. The blood-vessels found on reflecting the skin were markedly injected, and the blood fluid. The viscera were not sliced as it was desired to preserve the specimen with the organs *in situ*, for microscopical and cultivation purposes small pieces were obtained through areas on the under parts of the organs, previously seared in the usual way with a hot knife-blade. The smear preparations and cultures showed the bacilli already described.

A second guinea-pig, inoculated on 30th January with a small piece of the spleen of guinea-pig No. 1, became sick on 29th January, was very sick during 31st January and 2nd February, and died at 1·30 p.m. on 2nd February, having thus become sick in two days, and died in about four days. The *post-mortem* appearances were similar to those of guinea-pig No. 1, except that the spleen, though twice the normal size, did not show the miliary-tubercle-like appearance.

From the foregoing description of the bacteriological examination of material obtained from the enlarged femoral gland of A.P., it will be seen that two microbes were isolated—(*a*) a micrococcus still undetermined, but most likely one of the varieties of staphylococcus pyogenes albus; and (*b*) a bacillus answering positively to all the immediately applicable tests for *Bacillus Pestis Bubonicæ*.

FRANK TIDSWELL.

3.—EPIDEMIOLOGICAL RELATIONS.

A.P. was a lorry-driver, employed by the Central Wharf Company. His chief occupation was carting exports from city warehouses to the wharf, and delivering them either at his employer's warehouse or at the ship's side. For several months past he had been thus engaged in carting wool almost exclusively. Occasionally he used a truck to run goods from the warehouse across the wharf. He had not handled goods discharged from any ship since the previous August. He had no business on board ships, though he may occasionally have carried a message to the mates; and he had not been below on any ship for three months past at all events. Since Christmas he had only visited one other wharf, that of the A.U.S.N. Co., on January 9th, when he removed green hides imported from Queensland to a city warehouse. Both steam and sailing vessels from plague-infected ports must by this time (namely, near the end of the sixth year from the date of declaration of the epidemic at Hongkong) have discharged or loaded at every suitable wharf in the harbour; and, as regards Central Wharf alone, between November 1st and January 20th four steamships, which all carried Chinese crews, and which had all touched at Hongkong, had lain there—one of them from January 9th to 20th.

4.—LOCAL CONDITIONS.

A.P. had lived in the house where he was found for eight years (see illustration). It was built of brick, on a sandstone ridge, which sloped rather steeply to a branch of the harbour, within the city limits, and in a neighbourhood containing many large warehouses. It had two stories, four rooms, a small attic, and an unused basement, of which the natural rock formed the floor. It was in average general repair, but the sewerage was seriously defective.[*] There were no inside fittings, but there was a yard gulley halfway down the small walled yard, and a water-closet at the end of it. These were drained by 6-inch glazed E.W.P., which ran forward under the house in a chase cut in the rock floor of the basement. The drain was in aërial connection with the sewer, and the last length of piping against the front wall of the house had had a considerable hole knocked in it; the interior of the dwelling was thus brought into direct connection with the interior of the sewer. On the other hand, however, the basement had a large opening at pavement level in its front wall, and a door at the back, both of which were said to be kept constantly open. The drain junctioned with a very old oviform rubble sewer, which discharged on the foreshore at Dalton's Wharf, about 50 feet below the house and about 150 yards away, next to the Central, and which was unprovided with any tide-flap. Very few houses were connected with it, and its chief use seemed to be discharge of storm-waters. In every domestic respect the house was tidy, clean, and well-kept.

J. ASHBURTON THOMPSON.

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[*] This is too generally the case within the city of Sydney, which in this respect is very sharply distinguished from the rest of the Metropolitan area. In the latter sewerage is under exclusive control of the Metropolitan Board of Water Supply and Sewerage; and the 38,000 houses, containing 182,000 persons, to which the Board's service had been extended down to December 31st, 1899, are in every case connected on the most approved principles.

APPENDIX N.

APPENDIX N.

Circular. Form No. 236.

Department of Public Health, New South Wales, Sydney, 8 February, 1900.

Bubonic Plague.

Sir,

I do myself the honor to draw your attention to the enclosed copy of *Supplementary Government Gazette* of the 6th instant, No. 108, in which Plague is proclaimed to be a notifiable disease under the Public Health Act, Part III, in accordance with Section 20 thereof.

2. In connection with this proclamation, I would point out that, whereas notification of the commoner infectious diseases is properly not required until the diagnosis has become clear [see Public Health Act, Section 21 (b)], it is desirable in the general public interest that a somewhat different course should be taken with Plague. Success in the prevention of this disease depends so largely on early knowledge of all cases which occur that, although it is not the law, I venture to urge upon you the desirability of notifying not only declared cases, but also those in which the clinical symptoms, the patient's occupations, his recent movements, &c., &c., furnish ground for reasonable suspicion of plague.

I have, &c.,
J. ASHBURTON THOMPSON,
Chief Medical Officer of the Government.

APPENDIX O.

Department of Public Health, N.S.W. Form 247.

Directions for Special Cleansing and Disinfecting, issued to the Staff of Sanitary Inspectors, Scavengers, &c.

LIMEWASH ceilings whenever dirty, and in all small property; spare good ceilings in good condition or decorated, &c., &c.

Limewash all whitened walls afresh; limewash all cellar, basement, and outhouse walls.

Swab all woodwork thoroughly with carbolic water—include sash frames, window cases, &c.

Remove all floor coverings; have carpets beaten; oilcloth, &c., to be washed with carbolic water on both sides. Scrub the floors if of boards, and swab with carbolic water. Thoroughly saturate inside stone and brick floorings with carbolic water.

Saturate all outside pavements and soil with sulphuric acid water.

All lumber and the like not in actual use must be removed from the premises and not returned to them. All wastes, garbage, ashes, dung, stable bedding, &c., &c., must be removed, and stable bedding renewed with clean stuff.

Stable floors, if of wood, or likely to be foul beneath, must be torn up, the surface below thoroughly cleansed as described, and replaced with good floors properly close-jointed and caulked, well-bedded on a sound bottom, and graded to a gutter. The gutter must be placed in communication with a gulley leading to the sewer.

All drains, gullies, sinks, water-closets must be first flushed with hot water. They must then be flushed with carbolic water, and afterwards be kept dressed with chloride of lime.

In warehouses, &c., merchandise (except heavy machinery) must be moved so as to give access to walls for cleansing, &c., and to the floor on which it has been standing.

All makeshift buildings and sheds in bad repair will be condemned, and must be pulled down and removed before the premises can be passed as clean.

Occupants of premises which have been passed as clean will be furnished with a small placard, which they may affix in a conspicuous position, stating that the premises have been cleansed in accordance with the requirements of the Board.

Solid Disinfectant.—Chloride of lime.

Liquid Disinfectants.—Carbolic water—Miscible carbolic, $\frac{3}{4}$ pint. Water, 1 gallon.

Sulphuric acid water.—Sulphuric acid, $\frac{1}{2}$ pint. Water, 1 gallon.

Carbolic limewhite.—Miscible carbolic, $\frac{1}{2}$ pint to the gallon.

By Order,
C. A. SIMMS,
Secretary.

Department of Public Health, New South Wales. Form No. 246.

THESE premises have been cleansed and disinfected, in accordance with the requirements of the Board.

C. A. SIMMS,
Secretary.

Address of premises,

Date,

Signed,

Sanitary Inspector in Charge.

No. . Department of Public Health. Form 250.

Notice to Cleanse and Disinfect, under the Public Health Act.

To occupier of situated at No. street.

The Board of Health, being of opinion that it is necessary that the premises occupied by you should be cleansed and disinfected, and that the drains of the said premises should also be cleansed and disinfected, and that certain articles should be destroyed, notice is hereby given that unless within twenty-four hours from the receipt of this notice you inform the Board of Health, in writing, that within a further period of hours you will carry out the cleansing and disinfecting operations, and the destruction of certain articles hereinafter mentioned, the Board of Health will enter on the said premises and carry out the said cleansing and disinfecting operations and the destruction of the said articles at your expense, in pursuance of the powers vested in them by the provisions of the Public Health Act.

Particulars of cleansing and disinfecting operations required

List of articles to be destroyed

Note.—All such cleansing and disinfecting operations, and the destruction of such articles, must be done to the satisfaction of a legally-qualified medical practitioner.

Date of Service
Hour of Service

Inspector.

Under this notice you may elect to take any of the following courses:—

"A" To cleanse and disinfect the premises yourself within the period mentioned in the notice.
"B" To request the Board of Health to undertake the cleansing and disinfecting of the premises.

Penalties for Non-compliance.

If, having elected to carry out the required operations, you fail to do so within the time mentioned, a breach of the Act will have been committed.

Note.—In addition to the penalties incurred under the Public Health Act, you will be liable to have your premises placed in quarantine and isolated.

C. A. SIMMS,
Secretary.

No. Form No. 265.

Department of Public Health, N.S.W.

Notice under the Public Health Act.

To occupier of situated at No. street.

You are hereby notified that the undermentioned works must be executed before your premises can be certified as sanitary,

To avoid institution of proceedings against you under the provisions of the Public Health Act, the improvements must be taken in hand at once, and most be completed within from date of service of this notice.

Date of Service . Inspector.
Hour of Service

[Five Plates, One Diagram, Four Plans.]

Sydney: William Applegate Gullick, Government Printer.—1901.

[7*s*. 6*d*.]

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PLATE 1.

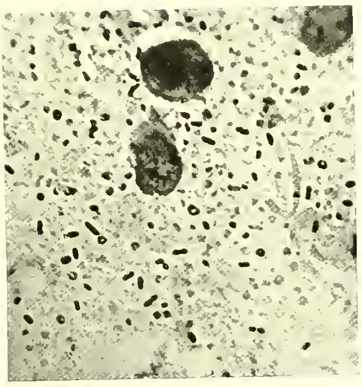

FIGURE 1.
FROM A BUBO. x 1000.

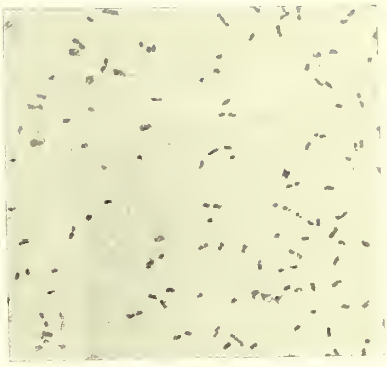

FIGURE 2.
FROM AN AGAR CULTURE. x 1000.

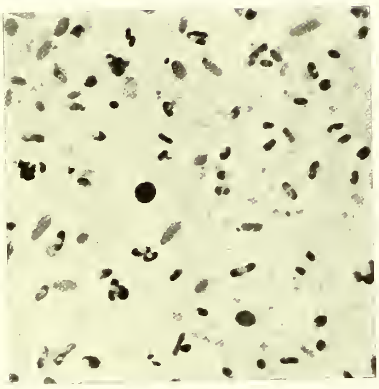

FIGURE 3.
FROM A DRY AGAR CULTURE. INVOLUTION FORMS.
x 1000.

FIGURE 4.
FROM A BOUILLON CULTURE. x 1000.

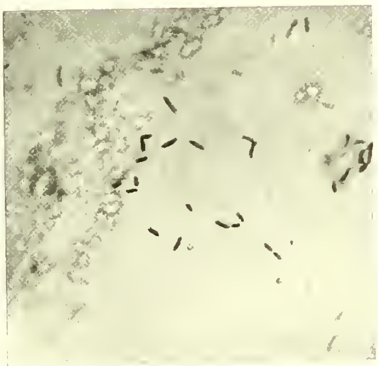

FIGURE 5.
SMEAR PREPARATION FROM A FLEA. x 1000.

Frank Tidswell.

BACILLUS PESTIS BUBONICÆ.

Seamen's Hospital Society
JUN. 1923
LIBRARY

PLATE 2.

FIGURE 6.

FROM A CARBUNCLE. CASE OF J.D. × 1000.

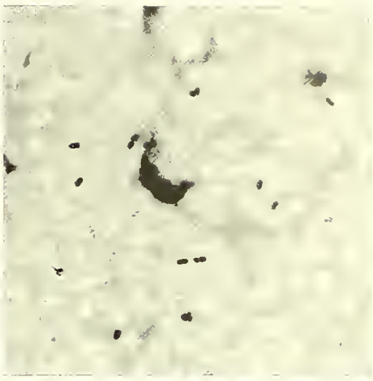

FIGURE 7.

FROM BLOOD OF HEART. INOCULATED GUINEA-PIG. × 1000.

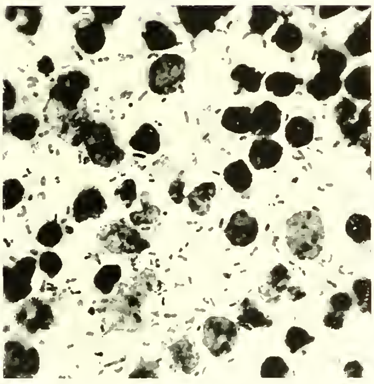

FIGURE 8.

FROM THE SPLEEN. CASE OF E. McC. × 1000.

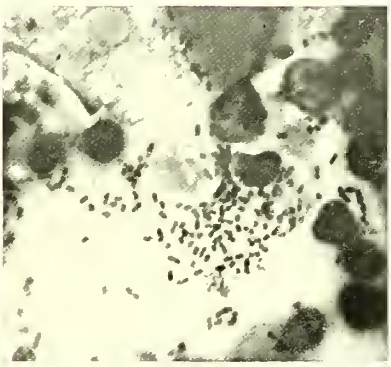

FIGURE 9.

FROM A BUBO. NATURALLY INFECTED CAT. × 1000.

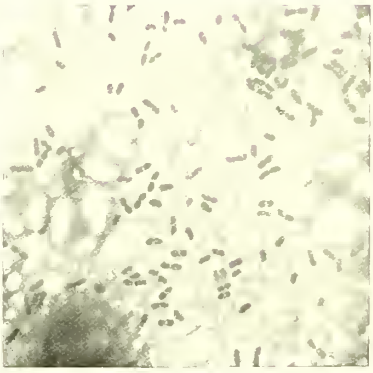

FIGURE 10.

FROM THE LIVER. NATURALLY INFECTED RAT. × 1000

Frank Tidswell.

BACILLUS PESTIS BUBONICÆ.

30 JUN. 1923
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Society

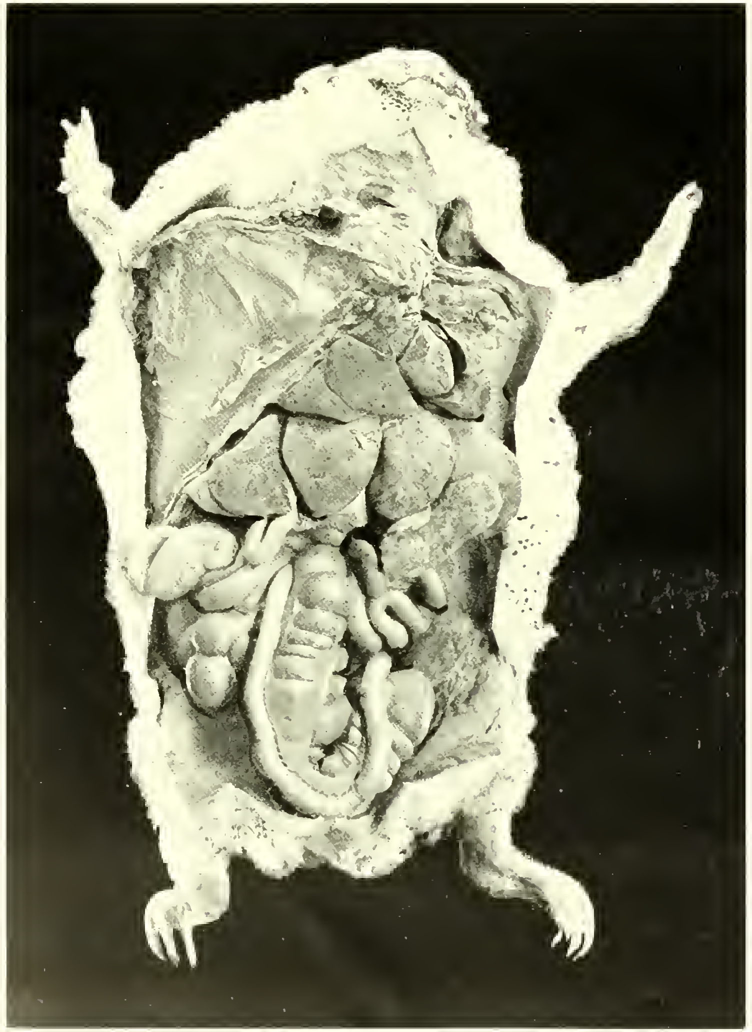

FIGURE 11.

PATHOLOGICAL APPEARANCES IN A GUINEA-PIG. PNEUMONIA, ENLARGEMENT OF THE LIVER, ENLARGEMENT AND MILIARY MOTTLING OF THE SPLEEN, BUBO IN THE LEFT GROIN.

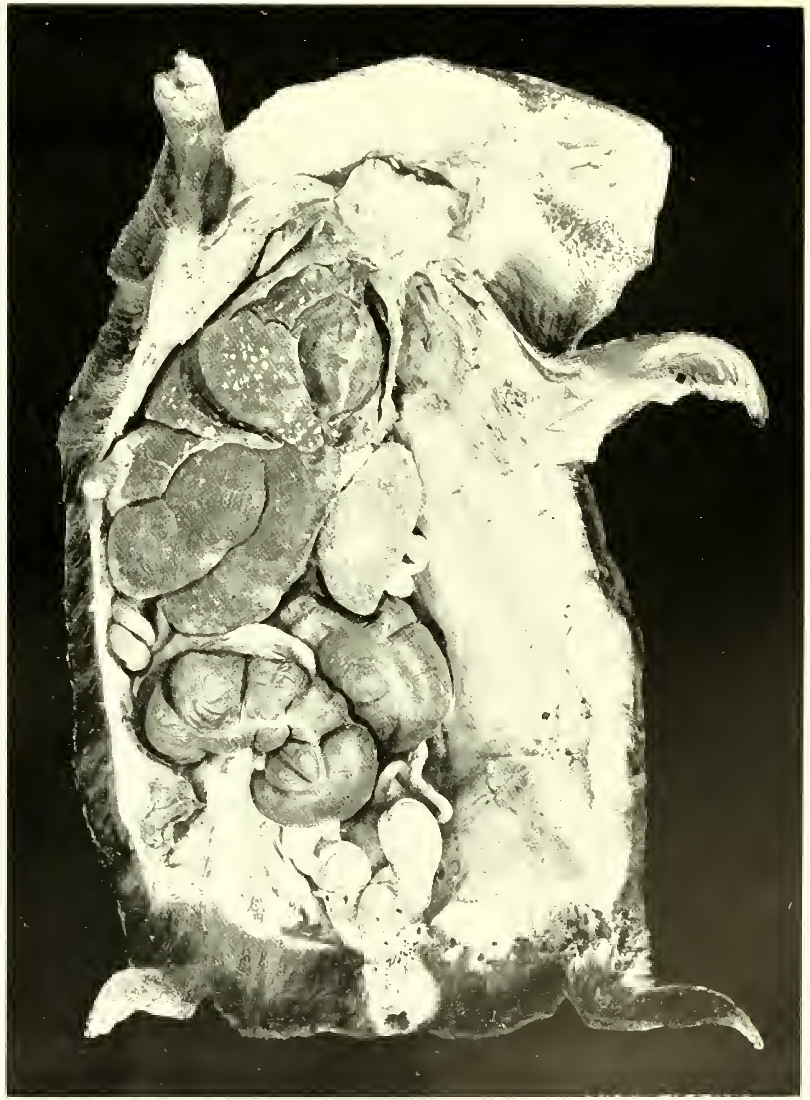

FIGURE 12.

PATHOLOGICAL APPEARANCES IN A GUINEA-PIG. PNEUMONIA WITH NECROTIC POINTS IN THE LUNGS, ENLARGEMENT OF THE LIVER, ENLARGEMENT AND MILIARY MOTTLING OF THE SPLEEN, BUBO IN THE RIGHT GROIN.

PATHOLOGICAL APPEARANCES IN INOCULATED GUINEA-PIGS.

Frank Tidswell.

Seamens Hospital Society
TROPICAL
DISEASES
19 JUN. 19[illegible]
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PLATE 4.

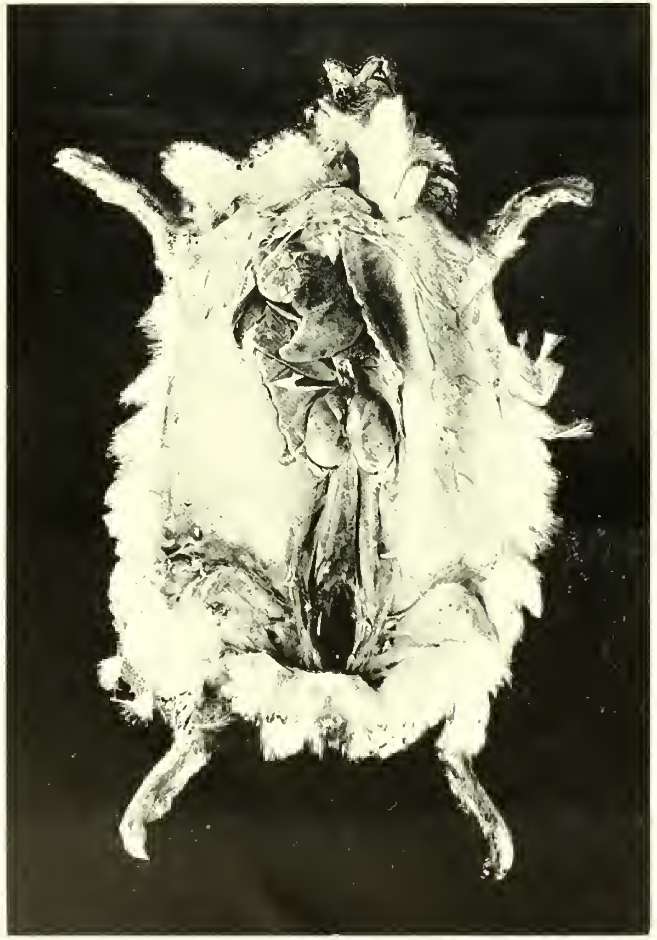


FIGURE 13.

DISSECTION OF AN INOCULATED GUINEA-PIG, SHOWING HÆMORRHAGES IN THE KIDNEYS, ENLARGEMENT AND CONGESTION OF THE SUPRARENAL BODIES, BUBO IN THE RIGHT GROIN, WITH HÆMORRHAGIC EXUDATION EXTENDING INTO THE PELVIS.

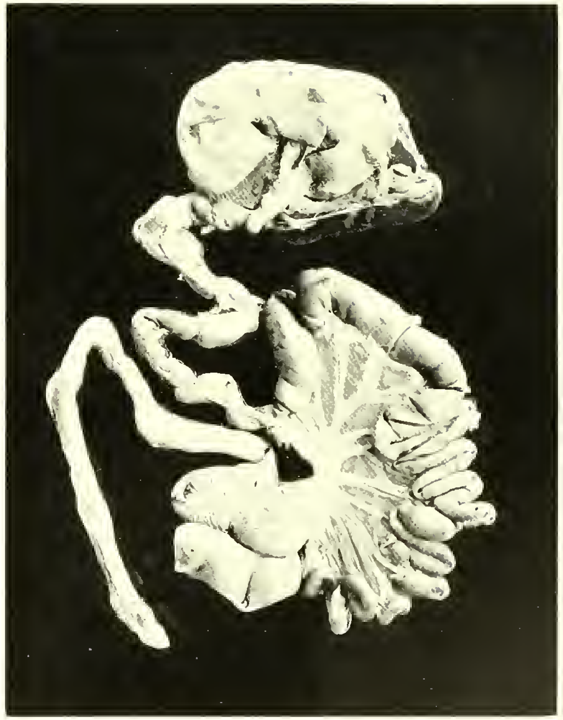


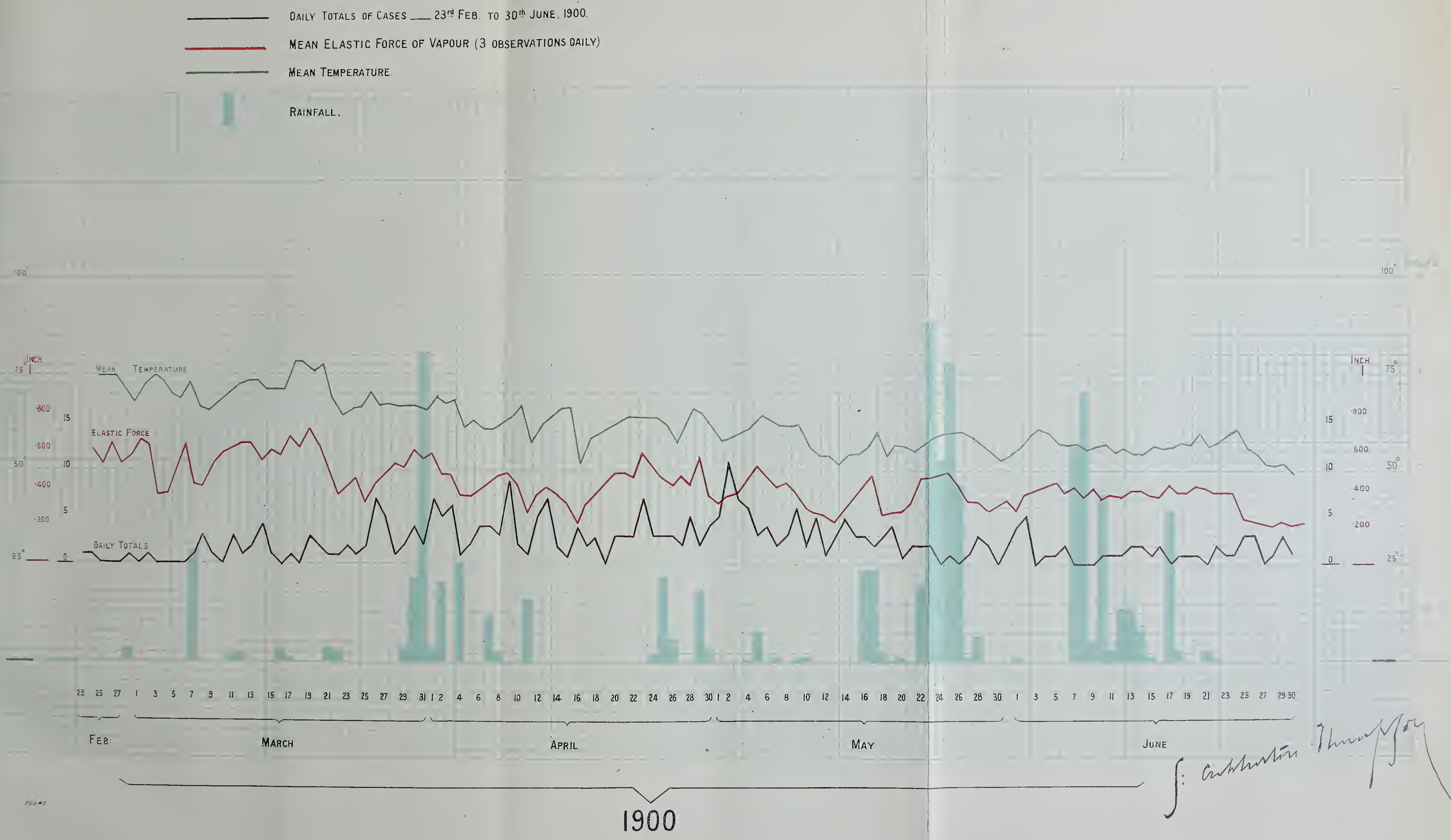
FIGURE 14.

DISSECTION OF THE GASTRO-INTESTINAL TRACT OF A RAT DEAD AFTER BEING FED UPON INFECTED VISCERA, SHOWING ENLARGED AND CONGESTED LYMPHATIC GLAND CONNECTED WITH THE STOMACH, CONGESTION OF THE MESENTERIC BLOOD-VESSELS, HÆMORRHAGIC EXUDATION AT FIRST PART OF LARGE INTESTINE, AND A MASS OF SWOLLEN MESENTERIC LYMPH GLANDS.

Frank Tidswell.

DISSECTIONS OF GUINEA-PIG AND RAT.

Seamen's Hospital Society
TROPICAL
DISEASES
19 JUN. 1923
LIBRARY



J. Ashburton Thompson

70247

Seamen's Hospital Society
TROPICAL DISEASES
19 JUN. 1923
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Nº of 146.00.587 B

MAP
of portion of
SYDNEY AND SUBURBS
SHEWING BY COLOURED SPOTS THE POSITIONS OF THE HOUSES OCCUPIED BY 294 PERSONS WHO SUFFERED FROM PLAGUE

EXPLANATORY NOTES

Black	*Spots*	*(32)*	*represent cases which occurred between*	*January*	*20th*	*& March*	*24th*	1900
Green	*„*	*(96)*	*„ „ „ „ „*	*March*	*25th*	*„ April*	*21st*	
Red	*„*	*(104)*	*„ „ „ „ „*	*April*	*22nd*	*„ May*	*19th*	
Blue	*„*	*(62)*	*„ „ „ „ „*	*May*	*20th*	*„ August*	*9th*	

The total cases were 303, 3 had no fixed residence and 6 cases at distant points (Westmead 1, Glenfield 1, Guildford 1, Sans Souci 1, Hurstville 1, and Marsfield 1), have been omitted so as to reduce the size of Map.

On this Map are shewn the position of the Maritime Quarantine Station where the Plague Hospital and Contact Camp were established, and that of the Quarantine Depôt where the Ambulance and Disinfecting Staffs were accommodated.

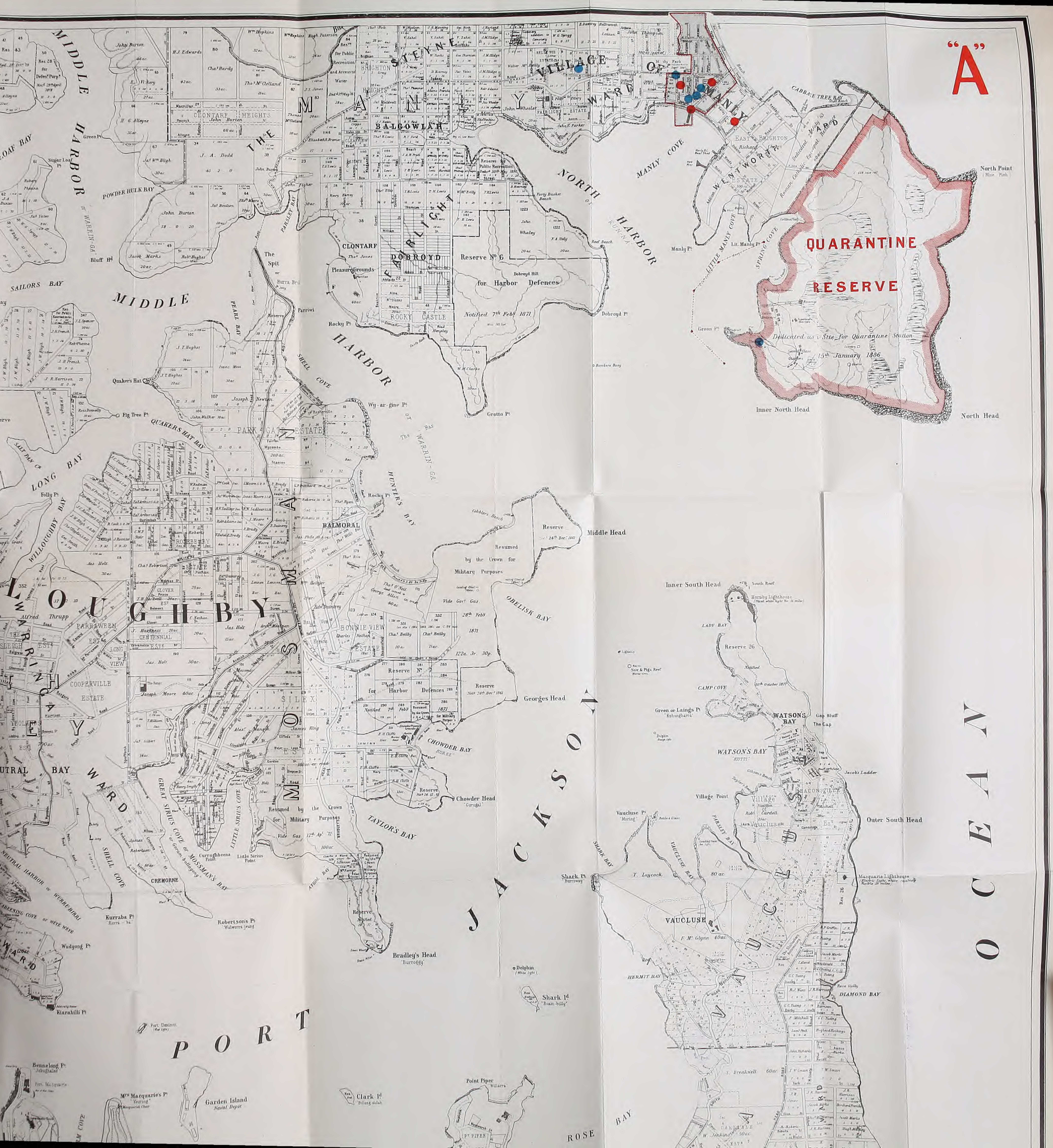
The Areas which were quarantined and cleansed are shewn thus 🟥

J. Ashburton Thompson
13 · 11 · 0

Lithographed and printed at the Department of Lands, Sydney, N.S.W. Novr 1900.

(Map in 2 Sheets)

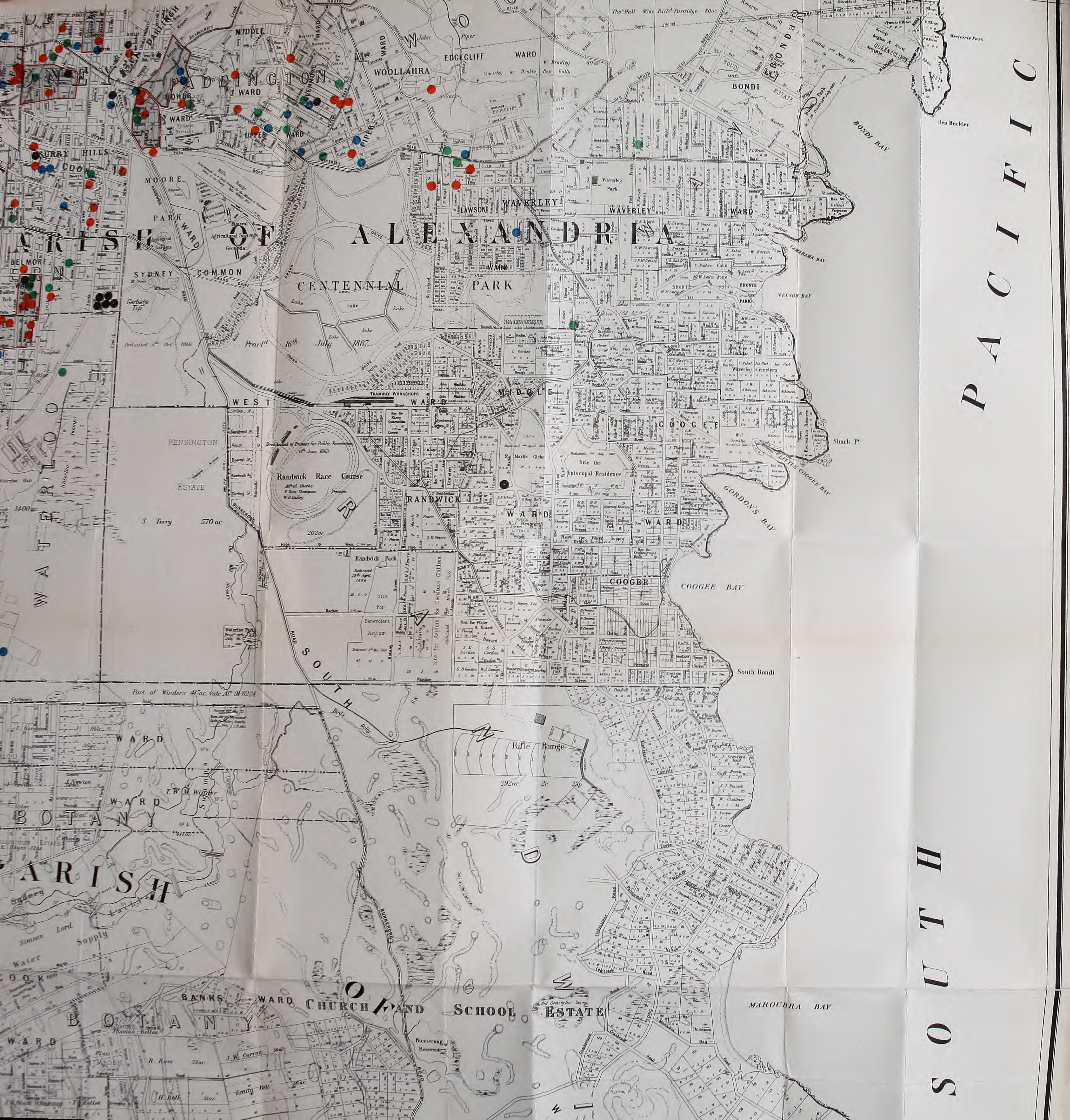
Kurraba Pt
Robertson's Pt
Wulwarra Jeung
Careening Cove
Wudgong Pt
WARD
Kiarabilli Pt
Reserve
Bradley's Head
"Burroggy"
J
Dolphin
Shark Id
"Boam-billy"
Fort Denison
PORT
Bennelong Pt
Fort Macquarie
Mrs Macquarie's Pt
Garden Island
Naval Depot
Clark Id
"Billong-ololah"
FARM COVE
BOURKE
WARD
Botanical Gardens
Domain
QUARANTINE DEPOT
WOOLLOOMOOLOO BAY
Potts Point
ELIZABETH BAY
Elizabeth Pt
"Jerrowan"
Macleay Pt
RUSHCUTTERS BAY
Rushcutter Bay Park
Darling Point
"Yarrandabby"
DOUBLE BAY
DOUBLE BAY WARD
DOUBLE BAY
BLACKBURN COVE
Point Piper
"Willarra"
Pt PIPER ESTE
John Piper 190 ac
ROSE BAY
Thos Benson 80ac
Thos Galvin 40ac
John Foster 80ac
Levey and Cooper Consolidated Grant
Jas. Brien 60ac
Wm Piper 1130 acres
S. Breakwell 60ac
W. Jenkins 50ac
CARLISLE ESTE
DOVER HEIGHTS ESTE
VAUCLUSE
F. Mc Glynn 40ac
HERMIT BAY
DIAMOND BAY
WENTWORTH ROAD
NEW SOUTH HEAD ROAD
OLD SOUTH HEAD ROAD
MILITARY ROAD
Francis Knight
Res. 26
JAMES
FITZROY
WARD
WOOLLOOMOOLOO
VAUCLUSE
WARD
O


"A"
QUARANTINE RESERVE
Dedicated as a Site for Quarantine Station 15th January 1886
North Point
North Head
Inner North Head
Cabbage Tree Bay
Manly
Manly Cove
Manly Pt
Little Manly Cove
Spring Cove
Lit. Manly Pt
Green Pt
East Brighton
Wentworth Estate
Village of Manly
The Manly Ward
Balgowlah
Brighton Heights
Fairlight
Clontarf Heights
Clontarf
Dobroyd
Rocky Castle
Reserve No 6 for Harbor Defences
Notified 7th Feby 1871
Dobroyd Hill
Dobroyd Pt
Forty Basket Beach
Reef Beach
North Harbor
Kunna
Grotto Pt
Rocky Pt
Middle Harbor
Warrin-ga
The Spit
Burra Bra
Pearl Bay
Parriwi
Powder Hulk Bay
Sugar Loaf Pt
Green Pt
Bluff Hd
Sailors Bay
Quakers Hat
Quakers Hat Bay
Fig Tree Pt
Long Bay
Folly Pt
Salt Pan Ck
Willoughby Bay
Willoughby Ward
Mosman Ward
Park Gate Estate
Wy-ar-gine Pt
Shell Cove
Hunters Bay
Balmoral
Rocky Pt
Cobblers Beach
Middle Head
Reserve
Resumed by the Crown for Military Purposes
Obelisk Bay
Bonnie View Estate
Reserve No for Harbor Defences
Georges Head
Chowder Bay
Chowder Head
Taylor's Bay
Athol Bay
Bradley's Head
Silex Estate
Rosebery
Glover Estate
Parraween
Centennial
Cooperville Estate
Neutral Bay
Great Sirius Cove
Little Sirius Cove
Little Sirius Point
Curraghbeena Point
Mossman's Bay
Cremorne
Robertson's Pt
Kurraba Pt
Wudgong Pt
Kiarabilli Pt
Fort Denison
Bennelong Pt
Fort Macquarie
Mrs Macquarie's Pt
Garden Island Naval Depot
Clark Id
Shark Id
Dolphin
Point Piper
Pt Piper
Rose Bay
Port Jackson
Inner South Head
South Reef
Hornby Lighthouse
Lady Bay
Reserve 26
Camp Cove
Green or Laings Pt
Watsons Bay
The Gap
Gap Bluff
Jacob's Ladder
Village Point
Vaucluse Pt
Parsley Bay
Vaucluse Bay
Vaucluse
Vaucluse Ward
Shark Pt
Shark Bay
Hermit Bay
Beaconsfield
Outer South Head
Macquarie Lighthouse
Diamond Bay
Ocean

Plague Map of Sydney and Suburbs _ No of Lith 00 587 D
Join Line
CONCORD
BURWOOD
ENFIELD
CANTERBURY
COOKS RIVER
PARISH OF PETERSHAM
MARRICKVILLE
ANNANDALE
LEICHHARDT
ASHFIELD
PETERSHAM
STANMORE
CAMPERDOWN
NEWTOWN
THE GLEBE
ULTIMO
SYDNEY
PADDINGTON
WOOLLAHRA
SURRY HILLS
REDFERN
ALEXANDRIA
WATERLOO
ERSKINEVILLE
ST PETERS
NORTH BOTANY
BOTANY
PARISH OF ALEXANDRIA
CENTENNIAL
MOORE PARK
SYDNEY COMMON
KENSINGTON ESTATE
Randwick Race Course
DOBROYD ESTATE
KINGSTON WARD
DENISON WARD
BELMORE
ROZELLE BAY
WATTLE COVE
IRON CREEK
LONG COVE
BOORALEE
BANKS WARD
Vide Govt Gazette 11th Aug 1882

R O C K D A L E
B E X L E Y
OF ST. G E O R G E
WARD
ROCKDALE WARD
BANKS WARD
BOTANY WARD
CHURCH
B O T A N Y
BOTANY BAY
Scale, 4 Inches = 1 Mile
ARNCLIFFE
KINGSGROVE ESTATE
ALPHINGTON
BOORALEE
BANKSMEADOW
KILLARNEY
Resumed for Sewerage Purposes
John Webb
300ac.
Area Reclaimed
120ac. Or 25p
Vide Govt Gazette 11th Augt 1882
Gov Gaz 29th July 1890
A. B. Spark
F. W. Unwin
Wm Beehag
Benjn Eve
Andrew Green
Hughes & Hosking
David Bedford
F. Mitchell
Wm Nicholls
J. Rothwell
R. Fuller
S. H. & J. Pearce
Thos Holt Junr
T. H. Bardwell
Jas Pike
Abraham Polack
Thos Sylvester
John Wiley
Chas Watson
John Miller
James Oatley
Capt John Townson
Ed. Flood
Mitchell
H. Bell
Emily Bell
Richard Stark
J. W. Curran
R. Ross
J. C. Phelps
Thomas Kellett
J. N. Brown
A. Byrne
COAST
ROCKDALE STN
BEXLEY

COOK
BANKS WARD
CHURCH AND SCHOOL ESTATE
MAROUBRA BAY
O
S
BOTANY
WARD
LEE
WARD
Bunnerong Reservoir
J.W. Curran 56ac.
R. Ross 53ac.
Emily Bell
H. Bell 53ac.
Richard Stark 56ac.
J.C. Phelps
H. Bell 53ac.
J.C. Phelps 53ac.
H. Bell 68ac.
BOTANY
Cook Street
Bunnerong St
BANKSMEADOW
Recreation Reserve
Coal Pier
T.B. Ball & J. Rothwell (Trustees)
J. N. Brown "Bunnerong" 131ac.
John Walsh
John Crane 10ac.
ROAD
Bunnerong Road
I WARD
BOTANY
Reserve
George St
Fitzroy St
Denison St
Cecil St
Franklin
Parker
Raglan
Napier
Wellington
Yarmouth
Victoria St
LONG BAY
LONG BAY
B A Y
Reserve No 15776 for Public Recreation
inches = 1 Mile


PADDINGTON
WARD
MIDDLE
WARD
WOOLLAHRA
EDGECLIFF
WARD
UPPER
WARD
PIPER
SURRY HILLS
MOORE PARK WARD
Victoria Barracks
Agricultural Society's Grounds
Zoological Gardens
BELMORE
SYDNEY COMMON
Garbage Tip
Dedicated 5th Octr 1866
PARISH OF ALEXANDRIA
CENTENNIAL PARK
Lake
Procld 16th July 1887
WAVERLEY
WAVERLEY WARD
LAWSON
WARD
Waverley Park
BONDI
BONDI ESTATE
BONDI BAY
Ben Buckler
Tho's Hall 80ac.
Rich'd Partridge 80ac.
Waverley or Double Bay Gully
Queenscliff
TAMARAMA BAY
BRONTE
NELSON BAY
Waverley Cemetery
Res. for Defence Purposes
PACIFIC
SOUTH
WEST WARD
TRAMWAY WORKSHOPS
MIDDLE WARD
KENSINGTON ESTATE
S. Terry 570 ac
Randwick Race Course
202ac
Dedicated to Trustees for Public Recreation 15th June 1863
St Marks Glebe
Site for Episcopal Residence
RANDWICK WARD
COOGEE
COOGEE WARD
Shark Pt
LITTLE COOGEE BAY
GORDON'S BAY
COOGEE BAY
Res. for Water Supply
Randwick Park
Site for Benevolent Asylum
Site for Asylum for Destitute Children
Res. for Water & Gravel
Waterloo Park
South Bondi
WATERLOO
1400 ac
Waterloo Swamp
Part of Winders 417ac. vide Alt. 91-8224
SOUTH
WARD
Rifle Range
292ac 2r 25p
WARD
BOTANY
PARISH
Lachlan Water Supply
Simeon Lord
COOK
BANKS WARD
BOTANY
WARD
CHURCH AND SCHOOL ESTATE
Bunnerong Reservoir
BUNNERONG ROAD
Old Seventy-four Swamp
MAROUBRA BAY
R. Ross 53ac
J. W. Curran
Emily Bell
H. Bell 53ac.
T. Kellar

MAP
of portion of

MAP
of portion of
SYDNEY AND SUBURB
SHEWING BY COLOURED SPOTS, THE POSITION OF PREMIS
AT WHICH 259 OF THE PERSONS
WHO SUFFERED FROM PLAGUE WERE EMPLOYED

EXPLANATORY NOTES

Black Spots (29) represent cases which occurred between January 20th & March 24
Green ,, (87) ,, ,, ,, ,, ,, March 25th ,, April 21
Red ,, (92) ,, ,, ,, ,, ,, April 22nd ,, May 19
Blue ,, (51) ,, ,, ,, ,, ,, May 20th ,, August 9

The total cases were 303; in 30 cases the place of employment remained unascertained or the patient was unemployed at the date of a
14 cases at distant points. (Manly 9, Quarantine Station 1, North Sydney 1, Hurstville 1, Sans Souci 1 and Glenfield 1) have been o
to reduce the size of Map.
The place of residence has been reckoned as the place of employment for house-wives, children etc.
The dates shewn in red on this map indicate neighbourhoods in which diseased or dead rats were observed by Officers of the Departmen
when they were observed — When the date is underlined the rats (or cat) referred to were rigidly proved in the Laboratories to be infected with p
The Areas which were quarantined and cleansed are shewn thus ▭

Scale 4 Inches = 1 Mile

Lithographed and Printed at the Dept. of Lands

MAP
of portion of
NEY AND SUBURBS
NG BY COLOURED SPOTS, THE POSITION OF PREMISES AT WHICH 259 OF THE PERSONS HO SUFFERED FROM PLAGUE WERE EMPLOYED

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,, (92) ,, ,, ,, ,, ,, April 22nd ,, May 19th
,, (51) ,, ,, ,, ,, ,, May 20th ,, August 9th
1900

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Map.

has been reckoned as the place of employment for house-wives, children etc.

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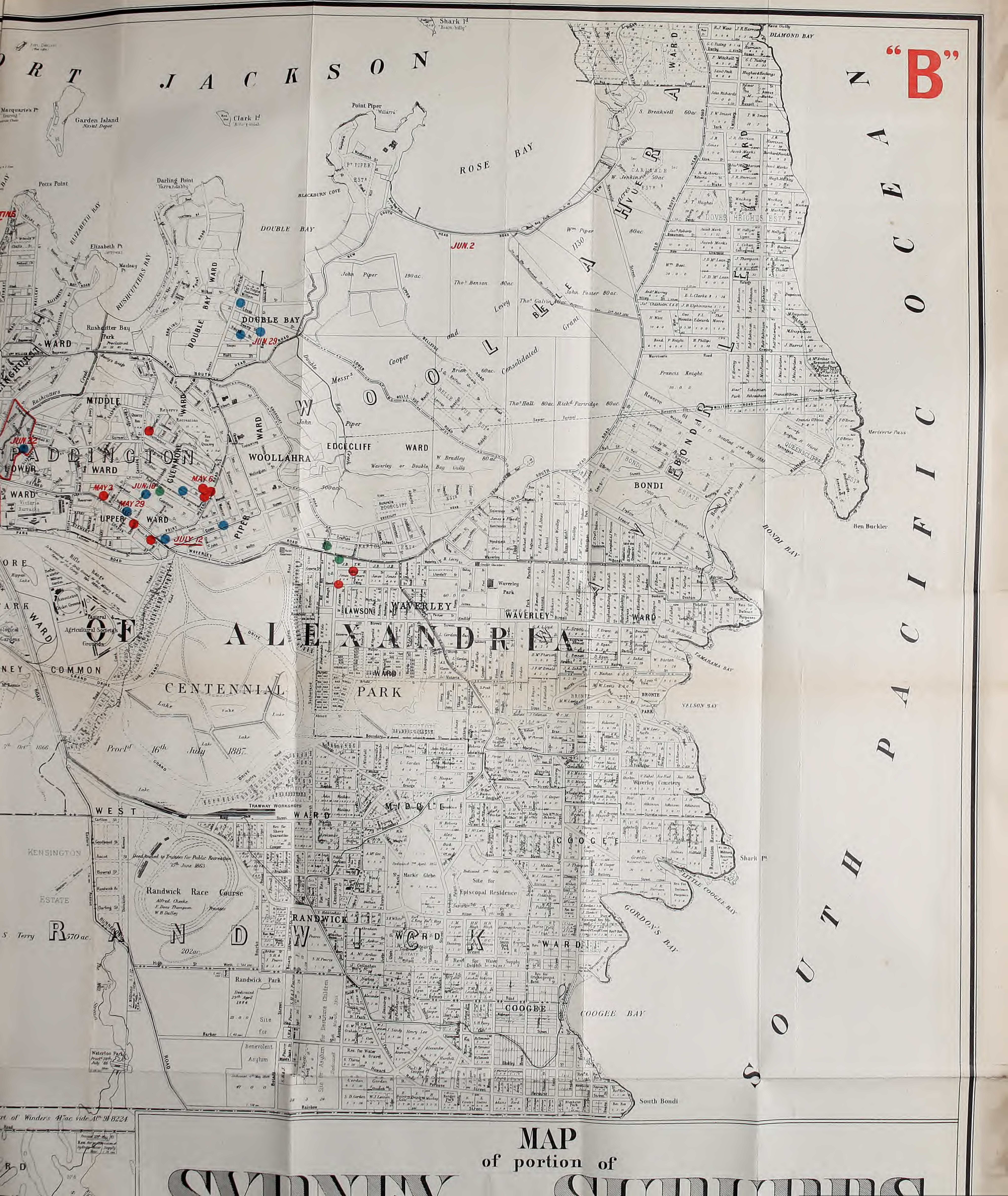
— When the date is underlined the rats (or cat) referred to were rigidly proved in the Laboratories to be infected with plague

arantined and cleansed are shewn thus ▭

J. Ashburton Thompson
13.11.0

Lithographed and Printed at the Dept. of Lands, Sydney. N.S.W. Novr, 1900.



MAP

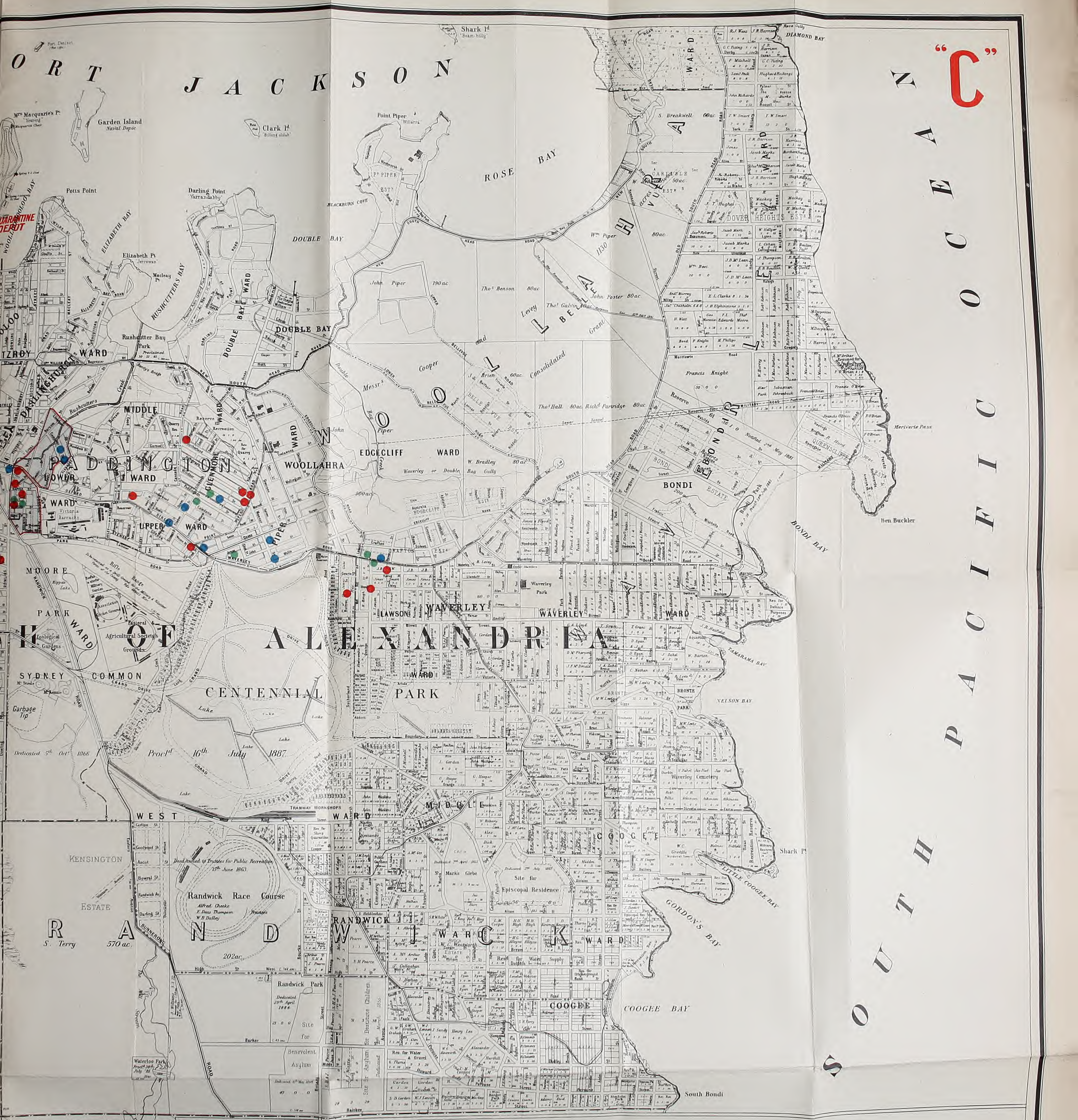
of portion of

SYDNEY SUBURBS

MAP

of portion of

"C"



MAP
of portion of

MAP

of portion of

SYDNEY AND SUBUR

SHEWING BY COLOURED SPOTS THE PROBABLE PLACE OF INFECT

IN 255 CASES OF PLAGUE

◆

EXPLANATORY NOTES

Black Spots (30) represent cases which occurred between January 20th & March 24th
Green " (92) " " " " " March 25th " April 21st
Red " (88) " " " " " April 22nd " May 19th
Blue " (45) " " " " " May 20th " August 9th
1900

The total cases were 303; number omitted from this map, 48, made up as follows :- 9 cases which occurred at Manly and which were infected there, 1 similar case at Quarantine Station (See Map A); in the case of 10 Chinese, information as to residence, place of occupation etc. was untrustworthy; the cases of 10 schoolchildren are omitted; and in 18 other cases the probable place of infection remained undetermined, the information being insufficient.

The Areas which were quarantined and cleansed are shewn thus ▭

——Scale, 4 Inches = 1 Mile——

Lithographed and printed at the Department of Lands, Sydney, N.S.W. Nov^r 1900.

J. Ashburton

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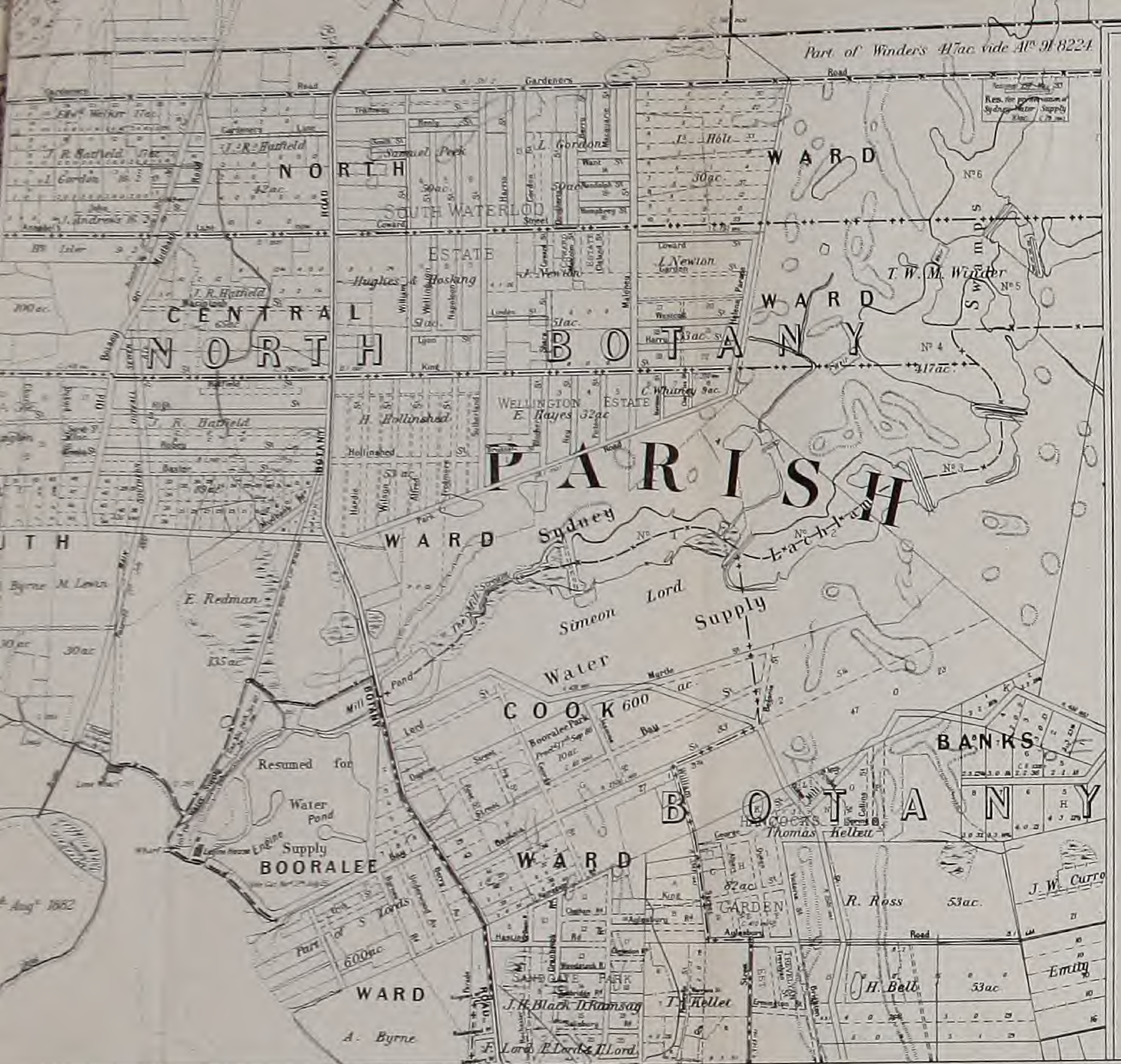

MAP
of portion of
SYDNEY AND SUBURBS
SHEWING BY COLOURED SPOTS THE PROBABLE PLACE OF INFECTION IN 255 CASES OF PLAGUE

EXPLANATORY NOTES

Black Spots (30) represent cases which occurred between January 20th & March 24th
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The Areas which were quarantined and cleansed are shewn thus ▭

Scale, 4 Inches = 1 Mile

J. Ashburton Thompson
13·11·0

Lithographed and printed at the Department of Lands, Sydney, N.S.W. Novr 1900.

1903.

Legislative Assembly.
NEW SOUTH WALES.

REPORT

OF THE

BOARD OF HEALTH

ON A

SECOND OUTBREAK OF PLAGUE AT SYDNEY,

1902.

BY

J. ASHBURTON THOMPSON, M.D., D.P.H., President,
Chief Medical Officer of the Government.

Printed under No. 12 Report from Printing Committee, 1 October, 1903.

SYDNEY: WILLIAM APPLEGATE GULLICK, GOVERNMENT PRINTER.

1903.
[2s. 6d.]

19354 *50—a

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- Evidence as to Place Infection.
- Origin of the Epidemic.
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- The case of the barque "Eulomene."

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APPENDIX.

[Twenty-eight Tables. Four Diagrams. Two Plates.]

REPORT

OF THE

BOARD OF HEALTH

ON A

SECOND OUTBREAK OF PLAGUE AT SYDNEY,

1902.

BY

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Chief Medical Officer of the Government.

PREFACE.

July 31*st*, 1903.

On reviewing the events of the epidemic of 1902, it appears that they justify and enforce the advice on management of epidemic plague which was given in the official "Report on the Outbreak of Plague at Sydney, 1900"; this, therefore, need not be repeated on the present occasion, which will be used to investigate further the causes of epidemic plague.

2. In other parts of the world, the maintenance and spread of plague are ascribed to human intercourse—directly with the sick, or indirectly through articles which have been infected by them—and to place-infection.

3. It has been shown that the epidemic of 1900 was not caused by direct communication with the sick, nor by diffusion of infected articles, nor by place-infection. These observations on the mode of spread we have now had opportunity of checking. They have been confirmed and amplified.

4. The share which may be played by the rat in causation of epidemic plague has been left a doubtful matter by the evidence which has been gathered elsewhere. All that has been ascertained is that man and the rat are susceptible of an identical infection. That plague is primarily a disease of the rat; that it is commonly communicated to man from the rat; or that man and the rat in usual circumstances of propinquity are reciprocally infective, have but been shown to be probable conjectures; for it has also been said* that sometimes an epidemic has taken precedence of the epizoötic, and even that in different places each has run its course unattended by the other. In short, no more than an occasional, though frequent, concurrence between the two has been remarked, and the question whether epizoötic plague be a cause or an incident of epidemic plague has been left unanswered by the observations thus far recorded in other countries.

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* Indian Plague Commission, Report 1901, Section 292.

5. Here, in Sydney, we formed the opinion in 1900 that plague-rats constituted the sole source from which the infection was communicated to man. A good deal of evidence in support was furnished, but it was, and under then circumstances almost necessarily was, incomplete. It has now been largely supplemented. How far it reaches towards demonstration of causative association between plague-rats and individual cases of plague is left to the reader's judgment. It is shown below that the task of fully examining into, and of exhibiting, the relationship referred to is one of great difficulty in any city.

6. But supposing the invariable precedence of rat plague and a constant association of plague-rats with individual plague cases to be established: Another and important difficulty presents itself, which is that in all probability the rat unaided cannot cause epidemic bubonic plague. An intermediary is necessary to convey this septicæmia of the rat to man. Whether that intermediary may consist in inanimate objects on which plague-rats have deposited the infection in a way to facilitate its effective contact with man, is a question which is discussed at length below. Some ground for answering it in the negative is there shown.

7. It has been already noted (Report, 1900, p. 38) that Simond had suggested in 1898[*] that the requisite intermediary might be furnished by the flea and the bed-bug. Personally, I had accepted this suggestion before the disease had appeared here, on the ground that it served to explain a greater number of reported, and apparently discordant, observations than any other which had been made; and when the first case of the epidemic of 1900 occurred which, as it happened, indirectly exemplified it, I took it for guide, although the proofs adduced had remained uncorroborated, and although direct experiments by Nuttall[†] (which were made, however, with Cimex only) had yielded negative results. By the end of that epidemic it had been generally accepted in this Department on the ground that it, and it alone, appeared capable of co-ordinating the observed facts; and, notwithstanding an adverse remark on "rat-fleas" made by Netter[‡], and vivacious contributions on the same subject by Professor Galli-Valerio[§], which intervened, we regarded it with similar favour at the end of the second epidemic. Attention has now been given to determining the species of the fleas which infest rats in this part of the world, to variations in their frequency on rats at different times, and to examining into their ability to bite man.

8. The importance of the foregoing remarks, which, to those who are content with the simple theory which is expressed in the one word "rat," will appear recondite and superfluous, lies in this: That while our experience regarding non-diffusion of the infection by direct or indirect communication with the sick and non-maintenance by place-infection, is not the same as has elsewhere been recorded, it has yet been acted upon by us with an apparent diminution of the number of persons attacked, together with large saving of direct expenditure, and avoidance of many of the indirect occasions of loss to individuals which, in spite of our advice, were caused to operate so largely during the first epidemic.

9. And now, unnecessary though it be to repeat all the advice on management of epidemic plague which was given in 1900, because it has but been corroborated by the further experience of 1902, it is yet well to recall the most important of the lessons which we then inculcated. This, repeated to-day with the emphasis which such corroboration warrants, runs as follows:—The promise of safety for the future lies neither with attempts to prevent the importation of plague-rats (which must fail from time to time), nor with attempts to exterminate the rats infesting the locality to be defended (which we have learned is practically impossible), though both of these measures have their valuable uses, but in habitually excluding rats from inhabited premises. This, manifestly, is a defence which can be set up successfully by Local Authorities; it requires persistent effort, but involves hardly any expenditure of municipal funds.

PART I.

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[*] Annales de l'Institut Pasteur, 1898. [†] Johns Hopkins Hospital Reports, VIII, pp. 17–21. [‡] La Peste et son Microb., Paris, 1900. [§] Cent. f. Bakter, XXVII, p. 1, and XXVIII, p. 842.

Part I.—The Epidemic.

10. The last case of the epidemic of 1900 was notified on 9th August of that year. An interval of rather more than fifteen months ensued, during which careful watch was kept for commencement of the recurrence which was feared; but among the many cases which were reported for diagnosis during its continuance, there were but two which afforded good ground for *primâ facie* suspicion, and after investigation it was shown that both were due to streptococcic infection. The rats which infested the areas on which cases had arisen were also watched until it appeared probable that the epizoötic of plague which had prevailed among them had died out.

11. That long interval was determined by attack of a man on 4th November, 1901; his case was notified on 12th November. A free term of thirty-four days ensued, and then, on 8th December, a second man was attacked. After a further free term of about thirty-five days, a woman fell ill on 10th or 11th January, 1902. During these two intermissions several cases of illness were reported for diagnosis, but no case of plague, nor any in which there was real ground for doubt, was among them. The epidemic declared itself with the third case, and, as the last patient was attacked on 8th June, it may be referred to conveniently as the epidemic of 1902. It consisted of 139 cases, of which 39 ended fatally, and is the subject of the present account.

12. On 6th August, however, one further case occurred at Newcastle. It was "indigenous" to that city, but, thanks to the measures immediately taken it remained solitary, and the danger to which that important seaport had been exposed was averted. It is separately described below.

Management of the Epidemic.

13. Management of the epidemic rested with the Board of Health. Mr. Edmund Fosbery, C.M.G., who had been appointed by the Board to act as President during my absence on leave, and the Principal Assistant Medical Officer of the Government and Micro-Biologist to the Board (Dr. Frank Tidswell, M.B., D.P.H.), who at the same time had taken up the duties of the chief executive post, occupied those positions at its beginning. I resumed control on 7th March.

14. The method of management differed essentially from that actually followed in 1900 in three important respects. First, in 1900 we had pointed out, in the course of our report on the case of A.P. (Case 1), dated 7th February, that the Coast Hospital was the only suitable place to which plague cases could be sent for isolation and treatment, and had repeated this recommendation several times during the earlier part of the epidemic. Secondly, we had announced, on 2nd March (Case 5), that it was unnecessary to segregate contacts, and that for the future we should, as a rule, remove only the sick from dwellings. Thirdly, on 23rd March (Case 32), we had so far expressed our opinion as regards probable diffusion of infection by merchandise as to give instructions that the latter might be removed in the ordinary course of trade from the Adelaide Bond, which stood on that infected area which was the first to be quarantined for cleansing. But the head of the Government of the day declined these several advices; and, as a matter of fact, patients were strictly isolated in the buildings, utterly inadequate to this purpose, and accessible with difficulty, which alone the Maritime Quarantine Station at North Head afforded, all contacts were segregated at the same place, and cleansing areas were as strictly closed, or "quarantined," during cleansing as physical circumstances permitted.

15. In 1902 our advice was implicitly accepted; and consequently, as regards the three points mentioned, we did as we had wished to do in 1900. First, the sick were sent to wards within the Infectious Diseases Division of the Coast Hospital, where they were dealt with almost exactly as though they had been suffering from measles or from some other of the commoner infectious fevers; the only difference was that visitors, though discouraged, were more freely admitted than would have been the case had the disease been measles in fact. No other special precaution was taken than that of rendering the wards rat-proof; and the general economy of the hospital was disturbed only by the number of patients suffering from this one disease for

whom accommodation had to be found. Secondly, the sick alone were removed from their dwellings. The other members of the households to which they belonged were not interfered with. They were told that their premises were probably infective, and were advised to withdraw from them until they had been disinfected, when the circumstances required this, but they were never compelled to move; neither were they supervised, except for a short time quite at beginning of the epidemic. Pending completion of disinfection, entrance to the house where the patient had lain was forbidden to all but the residents, but the latter were allowed to go in and out. Disinfection was always very promptly done, and was usually finished within thirty-six hours of the patient's removal; though in the case of extensive premises the time was much lengthened, and access to theatres, hotels, and the like was denied to the public until the structural repairs necessary to exclude rats had been completed. Thirdly, areas which were deemed to be infective were rapidly and thoroughly cleansed, but they were not closed during that operation; movement of population and trade were in no way interfered with.

16. These changes constituted remarkable ameliorations. Were they beneficial under all aspects? The following comparison permits the inference that they were so, and in a striking degree.

Table I.—Comparing the Epidemics of 1900 and of 1902, as regards number of attacks, fatality, and cost.

Epidemic.	Number of		Fatality.		Cost.
	Cases.	Deaths.	Gross.	Chinese Excluded.	
1900	303	103	34·0	32·4	£ 176,000
1902	139	39	28·0	25·75	24,000

Progress of the Epidemic.

17. At the Census of 1901 the population of the Metropolitan Registration District was 487,932, and this included a total of 3,842 Chinese, of whom only 222 were females. Among the whites 132 cases of plague occurred, of which 34 ended fatally; among the male Chinese 7 cases, of which 5 ended fatally. The manner in which these cases made appearance is shown in the Table below.

Table II.—Showing the number of attacks which occurred in each week of the epidemic, and the number of weekly attacks which ended fatally; together with the number of cases notified during each week.

	Attacks.	Deaths.	Notifications.		Attacks.	Deaths.	Notifications.
1901.				1902—(*contd.*)			
9 November	1	0	0	8th week— 1 March	14	4	16
16 ,,	0	0	1	9th ,, — 8 ,,	5	0	7
30 ,,	0	0	0	10th ,, —15 ,,	12	5	10
23 ,,	0	0	0	11th ,, —22 ,,	18	3	14
7 December	0	0	0	12th ,, —29 ,,	8	1	12
14 ,,	1	1	1	13th ,, — 5 April	5	0	5
21 ,,	0	0	0	14th ,, —12 ,,	1	0	4
28 ,,	0	0	0	15th ,, —19 ,,	6	1	4
1902.				16th ,, —26 ,,	8	2	7
4 January	0	0	0	17th ,, — 3 May	5	3	7
1st week—11 ,,	1	0	0	18th ,, —10 ,,	6	1	8
2nd ,, —18 ,,	2	0	1	19th ,, —17 ,,	7	3	5
3rd ,, —25 ,,	3	1	5	20th ,, —24 ,,	2	1	3
4th ,, — 1 February	0	0	0	21st ,, —31 ,,	2	0	1
5th ,, — 8 ,,	5	2	5	22nd ,, — 7 June	5	2	3
6th ,, —15 ,,	9	4	7	23rd ,, —14 ,,	1	0	5
7th ,, —22 ,,	12	5	8				
					139	39	139

18.

18. The first case occurred during the week ending 9th November, 1901. For thirty-four days it stood alone; a second then happened during the week ending 14th December. After another interval of thirty-five days a third person was attacked during the week ending 11th January, 1902, and with this the epidemic began. The first two cases being excepted, during the first six weeks (ending 15th February) 20 persons were attacked; during the second six weeks, 69 persons; during the third, 31; while during the latter five weeks, only 17 were attacked. These figures, which result from division of the series shown in Table II, column of attacks, in accordance with the marked increase in the weekly number of attacks during the seventh to the twelfth weeks, distinguish periods of increase, state, and decline of the epidemic. The onset of the epidemic was marked by extreme deliberateness at first, and by an almost regular acceleration in its later stages; while its end during the week ending 14th June was abrupt and decisive. No doubtful cases were met with thereafter.

19. *By whom notified.*—Of the above cases, 22 were notified from public hospitals, 92 by fifty-five medical practitioners, and the remaining 25 by staff medical officers, by coroners, by the police, by friends, and by themselves, in about equal numbers.

20. *Cases reported for Diagnosis.*—Between 12th November, 1901, when the first case was notified, and 31st July, 1903, 112 cases of illness, which turned out not to be plague, were reported for diagnosis. Only one of them afforded good clinical ground for doubt, but the morphological, cultural, and inoculation tests which were applied to liquid abstracted from a swollen inguinal gland failed to reveal any micro-organism or any infective disease. One other gave clinical ground for doubt in a lesser degree, and was shown to be a case of streptococcic infection connected with a chronic ulcer of the leg.

21. *Ambulant Cases.*—These did not exceed seven or eight in number altogether. But they could not be exactly discriminated, because they were exhibited both in persons who had personally applied for treatment immediately after attack and who subsequently passed through a well-marked illness, and in persons who had passed through a mild acute stage without medical aid, and who applied for help during convalescence, either for persistent weakness or for indurated and painful glands. This, with addition of two or three cases which ultimately came to light in consequence of late suppuration of glands, is what was observed during the epidemic of 1900; and, as on that occasion, the circumstances under which these cases came to notice render it likely enough that a few others may have occurred in which either advice never appeared to be necessary, or else was sought at so late a date that the true cause of illness was not discovered. Neither in 1900 nor during the epidemic under notice did we note anything which would give colour to a suggestion that cases of pestis minor occurred, or cases of benign glandular enlargement probably taking their origin from a very mild and successfully resisted infection with plague. We have no practical knowledge of either of these described conditions.

22. *Clinical Forms.*—Of the 139 cases, 133 were of the bubonic form, 6 were of the septicæmic form. These proportions were practically the same as were observed in 1900, and, as on that occasion, no case of primary plague-pneumonia was met with. The general course of the disease was the same as has been already described (see Report, 1900, pp. 3–7), but the following three clinical notes are worthy of record.

23. *Mode of Onset.*—This was often sudden. Thus the exact hour of attack was named by 22 patients; that is to say, they alleged that having been in good health they had fallen ill "at 5 o'clock in the morning," or "at half-past three in the afternoon," &c. In 71 cases, though the hour of attack could not be exactly fixed, yet it was ascertained to have been during the first 6 hours after midnight in 9 of them, during the second 6 hours in 18, during the third 6 hours in 22, and during the fourth in 22. So in 19 other cases in which nothing exact was noted on this point, in 8 the attack was said to have been "sudden," and in 11 others to have occurred "while at work." In 14 cases the onset was definitely ascertained to have been gradual.

24. *Onset Symptoms.*—These almost always consisted in headache and general malaise, nausea, followed sooner or later by vomiting, and shivering; a feeling of feverishness set in early, or else after a few hours. To these symptoms diarrhœa and colic were rather often added. At the onset, also, the patient's attention was frequently attracted to the gland in which the bubo afterwards developed. Thus, in 13 cases sharp and continued pain in the gland, accompanied or not by perceived enlargement, preceded all other symptoms, and was the first indication that the infection had been received; while in 24 others, similar pain with or without swelling was noted to have been among the onset symptoms, and to have been noticed as soon as headache, shivering, &c. had informed the patient that he was ill.

25. *Situation of Buboes.*—In 123 instances (32 deaths) the bubo was solitary; in 106 of these it was situated in the inguinal region, having been in one of the vertical set of glands in 60, and in one of the oblique set in 46 of them. In 10 instances (3 deaths) the glandular enlargements were multiple: in 2 instances (1 death) in two regions on the same side; in 7 instances (2 deaths) in the corresponding regions on two sides; and in 1 instance in two corresponding regions on two sides of the body. In 6 instances (4 deaths) there was no bubo.

26. *Interval between Attack and Notification.*—This can be stated in 139 cases, and was as follows:—

Table III.—Showing the interval which elapsed between attack and notification in 139 cases of plague.

Notified on the day of attack	10
,, one day after ,, ...	31
,, two days after ,, ...	27
,, three ,, ,, ...	31
,, four ,, ,, ...	13
,, five ,, ,, ...	9
,, six ,, ,, ...	5
,, seven ,, ,, ...	2
,, eight ,, ,, ...	4
,, nine ,, ,, ...	2
,, ten ,, ,, ...	3
,, eleven ,, ,, ...	1
,, twenty-three days after attack	1
Total	139

27. *Interval between Notification and Removal.*—This has administrative as well as ætiological interest. It was as follows:—

Table IV.—Showing the time which elapsed between the notification of cases, and their removal to hospital.

Removed on the day of notification	90
,, one day after ,, ...	28
,, two days after ,, ...	6
Not removed, having fallen ill in country	1
Died before or at notification	14
Total	139

So that of 124 patients who could be dealt with in the ordinary course, 118 were removed to hospital either on the day of notification, or, having been notified too late for removal by daylight, the next morning; while removal was deferred for two days in the remaining six cases, because the state of the patient at the date of notification was such as precluded his immediate removal with safety.

28. *Protective Inoculation.*—No public, and very little detail, inoculation was done during this epidemic. Two alone of the persons attacked asserted that they had been inoculated. Case 2: The patient was said to have been inoculated (Haffkine) at Rockhampton, Queensland, nearly 2 years before attack; this statement was verified*; he died. Case 95: The patient alleged that he had been inoculated (Haffkine) early in 1900, at Sydney, but his name could not be found in the list of names of persons then publicly inoculated; he recovered.

29. *Sex-incidence.*—Somewhat more than twice as many males were attacked as females. In 1900, this proportion was very much larger.

30.

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* By Dr. B. Burnett Ham, Commissioner for Public Health, Queensland.

30. *Age-incidence.*—The observed incidence was on ages 4 years to 75 years. About 60 per cent. of the total cases were aged between 15 and 35, and about 80 per cent. were aged between 15 and 45. A larger proportion of persons both above and below the age-groups mentioned was attacked in 1900.

Table V.—Showing the number of attacks and of deaths distributed under Sexes and Age Groups.

Age Group.	5		10		15		20		25		35		45		55		65		75		Total.	
Sex.	M.	F.	M.	F.	M.	F.	M.	F.	M.	F.	M.	F.	M.	F.	M.	F.	M.	F.	M.	F.	M.	F.
Attacks...	0	1	4	2	13	6	12	3	8	8	25	9	20	9	7	1	2	2	5	2	96	43
Deaths ...	0	1	1	0	3	1	4	0	4	0	6	3	6	2	1	0	1	2	2	2	28	11

31. *Fatality.*—The total number of cases having been 139, and the deaths 39, the gross fatality was almost exactly 28 per cent. ; and this was rather more than 6 per cent. below the gross fatality observed in 1900. Some part of this reduction may be apparent, and due merely to the smaller number of cases and of deaths dealt with; but as the gross fatality of 34 per cent. in 1900 was reduced to 32·4 per cent. for whites only, by deduction of 10 cases and 8 deaths among the Chinese, so the gross fatality of 28 in 1902 is reduced to 25·75 for whites only, on subtraction of 7 Chinese, and of the 5 deaths which occurred among them. These deductions are justifiable on the ground that experience has shown that the Chinese (and other coloured races) always resist this disease very much less successfully than do the whites.

32. *Fatality at successive periods.*—The fatality of the disease in each of the four successive periods already mentioned was as follows :—

Table VI, showing the fatality of the disease during four successive periods of the epidemic.

Period.	All cases.			Chinese deducted.		
	Cases.	Deaths.	Fatality.	Cases.	Deaths.	Fatality.
Early cases	2	1	...	2	1	...
1st– 6th week	20	7	35·0	20	7	35·
7th–12th „	69	18	26·0	67	17	25·3
13th–18th „	31	7	22·5	28	4	14·3
19th–23rd „	17	6	35·3	15	5	33·3
Totals	139	39	28·0	132	34	25·75

33. If the Chinese be deducted the fatality for these four successive terms becomes 35, 25, 14, and 33. The smallness of the figures dealt with may account for some irregularity in the series; and if the 4 periods be reduced to 2, namely, of 12 and of 11 weeks, then (the Chinese being still excluded) the fatality during them was 27·6 and 21· respectively. This seems to point to a diminishing virulence of the infection. But as the second term yielded but 43 cases much stress cannot be laid on this inference; and if the fourth column of the preceding Table be referred to, it appears that the fatality during the last of the four periods was rather above that of the first period. In this comparison, too, however, the figures are too small to carry weight. And yet just as it was necessary to point out that cases which seemed to betoken unimpaired virulence of the infection were met with at the very end of the epidemic of 1900 (Cases 289, 295, and 303), so now it has to be noted that of 6 persons attacked during the last fortnight of the second epidemic, 2 died, while one of these illnesses (Case 134) had a duration of seventy-five

seventy-five hours only, although the patient was a man of 24, and in excellent health at the time he received the infection. Extinction of the epidemic was not due, then, to enfeeblement of the virus, or if in some degree due to this, was not due to it alone.

34. *Fluctuation in the weekly number of attacks.*—The larger number of persons attacked during the second period of six weeks, was almost entirely associated with the city of Sydney, and very largely with that central part of the city along which George-street runs, and which is bounded on the west by Darling Harbour. That is the centre of the business portion of Sydney, and consequently is more thickly populated during day-light hours than any other. The persons referred to did not live in this locality, or did so in very small proportion; they merely resorted there during the day. Those of them who resided at a distance did so for the most part in neighbourhoods which there was no tangible reason for suspecting of infection with plague; on the other hand, they were easily connected with individual premises in that part of the city which were either shown to have yielded dead rats in number, or in the immediate neighbourhood of which rats actually infected with plague had been identified. In short, the weekly increase referred to appeared to be associated with wider prevalence of the epizoötic on a thickly-populated area.

Communication between successive Cases.

35. This was the subject of careful inquiry in every case. No communication was detected or suspected between any case and a preceding case, except on premises which yielded multiple cases; except also the 4 cases which occurred at 2 adjoining cottages on the Paddington area; except, also, 3 cases which occurred in two adjoining cottages on the Pyrmont area; except, lastly, case 102, Chippendale area, with which patient at the time of her attack (18th April) was a woman who had been seized 20th February, admitted to hospital 26th February, and discharged therefrom 18th March. All of the instances referred to are fully described in their place, and the nature of their relation to each other is there discussed at length.

Evidence as to Place Infection.

36. The Plague Commission in India summed up the evidence it had gathered as to place-infection and the maintenance of the disease by that condition in the following sentences:—" . . . the universal experience of plague in India proves . . . that houses into which the infection of plague has been imported, whether by men or by rats, are infective . . . "; and "the general experience on this question is summed up in the expression current in India that plague is essentially a disease of locality."* What evidence on this important point has been furnished by experience at Sydney?

37. In 1900 the number of dwellings which *harboured* cases of plague (that is to say, whether they were or were not adjudged places of infection for those cases) was 286. Only 10 of them yielded multiple cases; in 3 of them the secondary cases occurred before removal, and at or near the same time as the primary case; in 4 the secondary cases occurred after separation from the primary case, and from the dwelling; and in 3 only did the secondary cases occur among the household after its removal from the premises, after the latter had been disinfected, and after the household had returned to them. In this small minority of 3 dwellings out of 286, then, there was *primâ facie* evidence of place-infection; and the whole of that inquiry went to show that the epidemic was associated with place in some sense or another. But this localisation of the infection was considered to have consisted merely in the casual presence of plague-rats; and it was pointed out that infectiveness of some of the premises standing on an area otherwise known to be infective was just what might be expected to continue notwithstanding disinfection if it depended on the incoming of infected rats, and not on infection resident in the place itself.†

38. Further, 221 premises (whether dwellings or places of employment) were adjudged in 1900 to have been places at which 255 cases had received their infection (see Diagram C, 1900).

39.

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* Report 1901, par. 221. † Report, Sydney, 1900, p. 38.

39. Now, as regards 1902, we have in the first place to ascertain whether the second epidemic recurred on the same areas as were affected in 1900; and in order to judge this broadly, reference should be made to Diagram I.* On this 208 red spots have been placed which represent a corresponding number of adjudged places of infection in 1900; there are also 86 blue spots which represent the adjudged places of infection for 113 cases, in 1902.

40. It will be first noticed that red and blue spots are largely mixed together, and it will also be immediately perceived that on any hypothesis of spread, this must have been so to some extent, the reason being that while both sets of spots represent cases in man, the population among which they occurred was the same on both occasions, occupied the same area, and dwelt or worked in the same buildings; but on closer examination it will be found that large areas which carried many places of infection in 1900 were entirely spared in 1902. Secondly, when the individual premises are examined, it appears that out of the 286 houses which *harboured* (see par. 37) cases of plague in 1900, only eight again harboured cases in 1902. They were the following:—

1. Central Exchange Coffee Palace.—Case 135; cases 52, 53, and perhaps 2 others.
2. 47–51, Sussex-street.—Cases 2 and 29; case 42.
3. Her Majesty's Theatre and Hotel.—Cases 243 and 264; cases 18, 19, 20, 21, 33.
4. Criterion Theatre and Hotel.—Cases 227 and 236; cases 26, 27, 29, 31, 32, 39, 40.
5. Louden's Boot Factory, Elizabeth-street, Redfern.—Case 239; case 139.
6. Pier Hotel, Manly.—Case 257; case 110.
7. Saxton and Binn's Timber Wharf.—Cases 126 and 302; case 78.
8. 86, Windmill-street, Miller's Point.—Case 22; case 130.

41. The first 4 of these places were adjudged places of infection in both epidemics; the next 2 were so regarded in 1900 only, and the latter 2 in 1902 only. In 1900 the epizoötic extended to Manly, and there was a clear history of removal of dead rats by the patient, shortly before his attack, from the basement in which he was chiefly occupied. But in 1902 the most careful inquiry of the patient, who was a barmaid, and who apparently gave a full and straightforward account of her movements during the ten days which preceded her attack, entirely failed to reveal any probable source of her infection; the epizoötic having been ascertained as well as possible not to have extended to this waterside suburb on the latter occasion. As regards the last house mentioned in the above list it yielded in 1900 a single case of fulminant plague in a little girl; the house was old, and presented no signs of unusual infestation with rats. It was doubtful whether the patient had contracted the disease on the premises which, however, stood in the immediate neighbourhood of wharves in a locality largely occupied by warehouses, bonded stores, and the like places, and quite near to the lane in which the first case of that epidemic had occurred some two months earlier. In 1902 another little girl living in this house, but belonging to another family, was attacked; and, again, although the house yielded some evidence of infestation nothing definite nor, indeed, very suspicious, was discovered. But there was this slight difference in the known circumstances in 1902—a plague-rat had been collected on April 9th (the case occurred on May 15th) at Walker's Wharf, which was one of the line above which the house stood on a ridge. There was thus evidence of infection in the neighbourhood in 1902 which was wanting in 1900, though it may, nevertheless, well have been present then. Nothing of importance can be added concerning the 5th and 7th of the premises in the above list.

42. These 4 cases are, in my opinion, insufficient to raise a doubt; and the proper conclusion to be drawn from the whole number is that in those 4 most probably all the circumstances have not become known. The fact is that

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* Diagram I corresponds with diagram C attached to the Report, 1900; but whereas diagram C exhibited 255 spots, diagram I shows only 208. The main reason is that the spots on diagram C represented *cases*, but those on diagram I represent *places*; with the result that the number of spots then shown is reduced by 34. Besides this, diagram I does not cover quite as great an area as diagram C, and consequently 10 spots just to the east of its boundary, and 3 just to the south of it, are not shown; no cases having occurred in 1902 in the neighbourhoods thus indicated, nor beyond them.

of 6 premises which were adjudged places of infection in 1900, 4 were also adjudged places of infection in 1902. But the total adjudged places of infection in 1902 was 86; it follows that 80 of them were infected for the first time in 1902, while, on the other hand, 221 less 6 or 215 houses adjudged to have been places of infection in 1900 were spared in 1902: whence it is plain that the infection of 1900 showed no tendency to persist on individual premises. It will be noticed, also, that the 4 premises on which cases were adjudged to have been infected both in 1900 and in 1902, were used in ways known to be likely to attract rats to them.

43. It may be objected that so far cognisance has been taken only of premises in relation to cases in man, and that all of them were disinfected so effectually that the virus had no opportunity of establishing itself upon them. But the statement is that place-infection can also originate with introduction of infected rats to premises; now, although all those premises on which plague-rats were found were disinfected as carefully as though cases, too, had occurred upon them, yet it cannot be pretended that plague-rats were detected on all the premises which they had visited, or even where they had died. It might be supposed, therefore, that the 80 places of adjudged infection, apparently first made infective in 1902, may really represent that residuum of the many places which had been infected by plague-rats in 1900, which had then escaped disinfection, in which the virus had (*a*) succeeded in persisting, and in which (*b*) circumstances had secured its communication to man in 1902. To this, of course, no direct reply could be made. But after perusing the description of the mode of spread below, the reader will be in a position to judge how far the ascertained cause of the infectiveness of these houses in 1902 discounts the speculative supposition mentioned.

44. I conclude that there is no evidence of the occurrence at Sydney of place-infection in the Indian sense, and that the infectivity of premises in 1902 was due to the presence on them of the plague-rats of 1902.

Cases in which the place of Infection remained undetermined.

45. From the total 139 cases, one, attacked on board the ship "Eulomene," may be excepted; it is fully described below. Of the remaining 138 the place of infection was determined in 113; and that number of cases were adjudged to have received the infection on 86 different premises. Remain, therefore, 25 cases in which the available information did not suffice to indicate any particular place as probably having been that at which the infection was taken. Two of the 25 were Chinese; 4 of them were idlers or prostitutes; 3 were labourers out of work, who were taken ill while searching for employment; 3 others were boys under 15; and 3 were either rat-catchers or scavengers in employment of the local authority for the City of Sydney, whose occupation led them into special danger at many different places. There remain 10 cases, therefore, in which it might be reasonably expected that the place of their infection would be discoverable. The history of each of them prior to attack was very carefully inquired into, and although nothing of apparent importance was elicited, the following data concerning some of them are worth mention. One was a druggist; one was a groom, who slept over a stable and in the same building with his horses'-feed; another was a clergyman actively occupied in district-visiting; another habitually gathered mill-wastes for poultry-feed at places on the Darling Harbour area (see page 31); another was an unemployed man, apparently not an idler, but whose movements were obscure. Other 3 were housewives, one was a waitress at a restaurant, and one a barmaid (see par. 41). Evidently many of these persons ran, or were likely to run, into danger in the course of their occupation or idle wanderings, at a time when plague was epizoötic and epidemic.

Origin of the Epidemic.

46. The only hypotheses worth serious examination, in our opinion, are the two following: Either the epidemic depended on a recrudescence of the epizoötic of 1900, or upon a second epizoötic set going by newly imported plague-rats. As to the former, we had reason to believe that the epizoötic of 1900 died out in the course of that year, but the evidence gathered was insufficient to establish the fact; still, the recurrence was apparently too long delayed to have been a recrudescence, the interval

"DIAGRAM I"

PREPARED FOR THE DEPARTMENT OF PUBLIC HEALTH

MAP OF THE

CITY OF SYDNEY

AND

ADJACENT MUNICIPALITIES.

1903

COMPARING THE POSITION OF 208 ADJUDGED PLACES OF INFECTION IN 1900 WITH THAT OF 86 SUCH PLACES (SEE PARAGRAPH 39) IN 1902, AND DISTINGUISHING 7 WHICH HARBOURED CASES IN BOTH THOSE YEARS.

EXPLANATORY NOTES

Adjudged places of infection in 1900 by red square thus 🟥
" " " " 1902 " blue " 🟦
Places which harboured cases in 1900 & 1902 by red square within blue square thus ▣

NOTE
This Diagram corresponds with Diagram C, 1900, but shows fewer spots for reasons mentioned in a footnote to the preceding page.

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interval of fifteen months which elapsed before the disease again occurred having extended far beyond the time at which generations of new and susceptible rats had come into existence. Further, it will presently be shown that the state of rats as to disease was very carefully, and it is thought completely, ascertained over the whole of the threatened area from conclusion of the epidemic in June 1902, to 31st December, while from the latter date the wharfs were watched in the same thorough way until far into 1903. Now, the last plague-rat was discovered on 13th July, 1902; consequently there is good ground for asserting that the second epizoötic, at all events, died completely out: and therefore, as regards commencement of the second epizoötic, the balance of evidence at Sydney appears to tell in favour of reimportation. But this matter requires further observation in the field, and experiment in the laboratory, as the short table below concerning Western Australia pointedly suggests.

47. As to reimportation, Sydney remained in the communication by sea with all those ports in other parts of the world at which plague existed between August 1900 and November 1901, which was described before, (Report, 1900, p. 21), ports in New Caledonia alone excepted; but to them must be added some danger from two States of the Commonwealth, namely Western Australia and Queensland. The facts as regard Western Australia are shown in the table below:—

TABLE VII.—Showing the dates on which successive outbreaks of Plague in the State of Western Australia began and ended.

Year.	Number of Cases.	Locality.	Duration.
1900	6	Fremantle ...	April 5—June 18.
1901	23	Perth, Fremantle, and Kalgoorlie ...	March 1—May 11.*
1902	3	Fremantle ...	May 19—July 4.
1903	9	Fremantle ...	January 26—May 24.

* The cases occurred at Perth and in its suburbs for the most part; 2 at Fremantle, probably of local origin; and 1 at Kalgoorlie, a very distant place, thought also to have been infected at Perth.

Fremantle, at the mouth of the Swan River (population 16,367) is the port of Perth, which lies 12 miles higher up. Vessels coming foreign berth alongside; they do not ascend the river, but goods are carried up on lighters.

48. The important facts as regards Queensland were as follows in 1901:—

TABLE VIII.—Showing the cases of plague in rats and in man at Brisbane during the latter half of 1901.

	Cases in—	
	Rats.	Man.
July	20	3
August	8	1
September	1	......
October	......	1
November	1	......
December	......	1

49. One case was also reported from Bundaberg, Q., on 17th April, and one from Cairns, Q., on 16th July, both of which are seaports. Thus prior to November, 1901, the port of Sydney was in danger of importing plague-rats from Queensland, with which it is in daily communication by sea (by rail also with Brisbane), and perhaps also from Fremantle, though this seems uncertain. Precautionary measures were taken against this danger both at the distant ports mentioned and at this port, but these, as has already been pointed out (Report 1900, p. 44), cannot be relied upon invariably to prevent it. And it will be seen below that the rat-staff organised as soon as occurrence of Case 1 became known did on the second day of search (18th November) take a plague-rat at Howard Smith & Co's. Brisbane wharf; this being one of a line of wharfs, on the eastern side of Darling Harbour, at which produce is habitually landed, and the case having occurred at a produce store in the city which was distant from it. Nevertheless we are not at liberty to assume without reserve that the infection was brought hither either from Queensland or from Western Australia; for a vessel which has received plague-rats at a very distant port has arrived at Sydney

after a voyage at sea which had lasted so long as 29 days with some rats still alive; and actually suffering from plague at the time of her arrival. This occurrence was observed in March 1901, and was as follows :—

The Case of the S.S. "Antillian."

50. The chartered troopship "Antillian," a steam vessel of 3,686 tons, entered Sydney Harbour, March 2nd, 1901, and brought to at the Boarding Station. She had left Capetown, February 1st, and presented a clean bill of health issued to her at that port. She was completely fitted for carrying mounted troops, had shingle ballast, a crew of sixty-five persons all told, no cargo, and no passengers. On being boarded by the Port Health Officer (Dr. W. Peirce, M.D.) all hands were reported well except an A.B., who was thought (there was no surgeon on board) to be suffering from pleurisy. Information having reached the Department of the occurrence of plague at Capetown subsequent to departure thence of the "Antillian," the ship was at once placed under fumigation with burning sulphur, and the case of the sick sailor reported. Dr. W. G. Armstrong, M.B., D.P.H. M.O.H., for the combined Metropolitan Districts, was directed to visit the patient; he diagnosed plague (Case I). The vessel was sent to the Maritime Quarantine Station, and the patient was at once transferred to hospital; at the same time inoculation was offered to all hands, but only ten (mostly officers) accepted, though at later dates a few more were done.

51. The following account of Case I, prior to March 2nd, was taken from the ship's log; the remainder was furnished by Dr. Armstrong :—

Case I.—O. O., Norwegian, aged 19; a deck hand, not inoculated; spoke very little English; was reported to have been quite well until—

February 27th.—Complained of frontal headache and chilliness; he vomited several times after taking a little food, but had no persistent vomiting. At 4 p m., temperature 101°; began to feel pain in right axilla during the evening; took aperient medicine, which acted freely.

February 28th.—8 a.m., temperature 99·2°; midday, 101°; 8 p m., 103°. There was a swelling in the axilla which increased in size during this day.

March 1st.—8 a.m., temperature 100°; midday, 101°; 8 p.m , 103°. The swelling was poulticed.

March 2nd.—Was found lying in his bunk in the forecastle. Face flushed, conjunctivae injected; tongue slightly furred; temperature 104·8°, p. 120, merely febrile in character and without tendency to dicrotism. There is a large œdematous swelling in the right axilla, which extends downwards to about six inches below the anterior fold of the axilla, along the wall of the chest. In the upper and anterior part of the swelling is a well-defined hardness about the size of a walnut, situated beneath the *pectoralis major*. The whole of the swelling is very tender, but the hard portion especially so. The lymphatic gland above the inner condyle of the right humerus is swollen to the size of a hazelnut, reddened and tender. An enlarged and tender gland can be felt below the angle of the jaw on both sides. There are neither wounds nor excoriations on the right side of the body.

March 3rd.—Died during the afternoon.

52. On *March 2nd* Dr. Armstrong, after disinfecting the skin thoroughly, abstracted liquid with a sterile hypodermic needle from the deep hardened area in the axillary swelling, and from the enlarged supratrochlear gland. At the laboratory this was subjected to microscopical, cultural, and inoculation tests of exactly the same kind as those already fully described (Report, 1900, Appendix A). It was found to contain numerous bacilli easily recognisable as *b. pestis*; and they proved fatally and characteristically pathogenic for two guineapigs into which some of the liquid was injected.

53. The following account of a second case has been abstracted from the clinical record kept by Dr. A. E. Salter, in medical charge of the Quarantine Station :—

Case II.—W. J. W., aet. 23, storekeeper; not inoculated. During the night of *March 11th–12th* felt some stiffness or soreness about the right groin, which he supposed was due to strain.

March 12th.—On examination, one gland of the left femoral chain was found to be enlarged, hard, tender, and distinct; temperature normal; no constitutional symptoms. Has had several attacks of malarial fever during past years. Isolated for observation.

March 13th.—Had been delirious during the night, and had not slept. State of the enlarged gland unchanged; no periadenitic effusion. Temperature, 103°; pulse, 104; respiration, 28. Transferred to hospital. At midday 60 cc. of Yersin serum were injected subcutaneously; 40 cc. in the left, and 20 cc. in the right thigh. At 1·45 p.m. had a rigor; temperature, 107°. At 8·45 p.m. an attempt was made to inject 40 cc. of serum into the right median basilic vein, but only 10 cc. could be made to enter; the remainder was injected under the skin of the right flank. On this date the patient was visited by the Assistant Medical Officer of the Government (Dr. R. J. Millard, M.B., D.P.H.), and by Dr. Armstrong. Smears were made, and culture tubes inoculated, with liquid withdrawn from the bubo; the former showed a pleomorphic bacillus in large numbers which resembled *b. pestis*, while the latter in due course yielded pure cultivations of *b. pestis*. It was not thought necessary to apply any inoculation test to this bacillus, the clinical features of the case and the surrounding circumstances having already rendered the nature of the illness certain.

March 14th.—Had slept fairly well. Temperature, 99·8° morning, rising to 103° evening; eyes suffused; severe headache. At 10 a.m. 40 cc. of Yersin serum were injected under the skin of the right thigh; at 5 p.m. 40 cc. under skin of left calf.

March 15th.—Had slept better; urine offensive; bubo very painful; morning temperature, 99°; rising to 102·4° at night.

March 21st.—Has progressed favourably during the past week. On this date a profuse urticarial rash appeared, attended with much itching, &c.; temperature rose to 103·4°. The bubo was incised, giving exit to from 8 to 10 cc. of lumpy pus, and revealing a deep but not extensive cavity.

March 22nd.—The rash and irritation continue; very little discharge from bubo; was delirous all night.

March 31st.—A slough was discharged from the bubo; entered on convalescence.

54. On March 2nd Dr. Armstrong secured and carried to the Laboratories the putrid carcase of a rat (No. 1) found on board the "Antillian." On the whole this turned out to be too much decomposed for profitable examination; however, smears made from the inguinal glands revealed a bacillus resembling *b. pestis*, but cultures made from them and from other organs became overgrown in eighteen hours. On March 4th, the bodies of two more rats, which had been found dead on the "Antillian," were received.

55. Rat No. 2.—The skin showed very numerous petechial hæmorrhages, the abdominal cavity was full of blood-stained liquid; the liver was enlarged, soft, and full of punctate hæmorrhages; the spleen was enlarged, congested, and necrosed in one or two rather large patches; there were hæmorrhages in the kidneys and adrenals; the lungs were inflamed and blood-full. Smear preparations made from liver, lungs, spleen, and inguinal glands teemed with *b. pestis*, and pure cultures were recovered from all these organs. A guinea-pig inoculated in the right thigh with material from the liver of rat No. 2 died in seven days, and presented the appearances usual in inoculated plague; smear preparations made from its various organs revealed *b. pestis* in profusion, and pure cultures of *b. pestis* were recovered from the latter.

56. Rat No. 3.—The body of this animal presented exactly the same appearances as have been described above of rat No. 2, and direct and cultural tests yielded similar results. No inoculation tests were made, the nature of the disease being already unmistakable.

57. The master of the "Antillian," who took a lively and intelligent interest in the infection of his vessel, said that there were not many rats on board; but that, on the day of departure from Albany (February 22nd), some unusual, though not great, mortality was discovered among them in the course of cleansing operations, about fifteen carcases having been found and thrown overboard. He also said there were several good ratting cats on board, and that whereas these cats had occasionally brought rats they had caught to the bridge for inspection, after the above-mentioned mortality had been noticed they caught (or, at all events, exhibited) no more.

58. After leaving Albany all the deck hands (sixteen) except the quartermasters were employed in cleansing the holds under supervision of the mate and the boatswain; the log showed that all hands had been thus employed on February 22nd, 23rd, 25th, and 26th, but the work was continued in some degree almost until Sydney was reached (March 2nd). It was during these operations that the fifteen dead rats mentioned above were found. The sailors would not touch them—not because any danger was apprehended, it was said, but because they thought it was "not their work" to handle dead rats—and they were thrown overboard by the mate and the boatswain (neither of whom fell ill). O. O. was one of the sixteen deck hands, and was employed with them on the work just mentioned.

59. It has been mentioned already that the "Antillian" arrived completely fitted for carrying mounted troops, without any cargo or fodder, and in shingle ballast. But she brought a quite small quantity of food stores—biscuits, tea, confectionery, sugar, flour, &c., &c., all of which except 7 tons was securely cased. These stores were in charge of W. J. W., Case II, and they were stowed on the orlop deck in the most forward of the five compartments into which the hull was divided by water-tight and fixed bulk-heads. Below this part of the orlop deck a

small quantity of dried potatoes was stowed, but the other stores mentioned were parcelled out among several rooms temporarily constructed on the orlop deck. During the cleansing already mentioned these store-rooms were not touched.

60. The ship brought a clean bill of health issued to her at Capetown, and in answer to the usual questions her Master stated that neither plague nor any other epidemical disease existed there at the date of his departure (February 1st). But on February 12th news had reached the Department of the occurrence of plague in man at Capetown, two cases having been reported under date February 9th, and on the same date it was also reported that the dock rats had migrated from the South Arm of Capetown docks and had made their way to Green Point Camp. In view of these reports the "Antillian" had been placed under fumigation with sulphur almost immediately on arrival, and before the nature of O.O.'s illness was suspected. After the latter had been clinically recognised she was submitted to a second fumigation, which began on March 3rd, and continued till the morning of March 4th. Neither of these fumigations can have much affected the store-rooms, since these were separately built up within the forward compartment. On March 5th the store-rooms were inspected preliminary to directing special disinfection, and the carcases of one putrid and one desiccated rat were then found. The rooms and their contents were thoroughly sprayed with sublimate solution 1-500 by the Quarantine staff, and afterwards were fumigated with burning sulphur. On March 9th, the stores were transferred to a lighter under superintendence of W. J. W., Case II (when ten more carcases were found), so that the rooms might be more thoroughly cleaned; and this having been done, they were replaced on March 11th—again, under supervision of W. J. W. The latter, who had not been on board except on the dates mentioned, fell ill during the night of March 11th-12th; it is, therefore, most probable that he was infected on March 8th, during removal of the stores, this having been the third day before attack. Several other persons were engaged in this work, none of whom fell ill.

61. The previous history of the "Antillian" was compiled from the ship's logs, and was as follows. The "Antillian" left Southampton towards the end of 1899, and arrived at Capetown during the month of December. She remained on the South African Coast about seven months, going backwards and forwards between Capetown and Durban; she lay in the stream at the latter port, and usually lay alongside at Capetown. On July 23rd, 1900, she left Capetown for Hongkong, *via* Singapore. She reached Hongkong August 22nd, 1900, and lay in the stream; she discharged ammunition and received coal and stores, but did not go alongside there. On August 26th, 1900, she left Hongkong for Wei-hai-wei, where she arrived August 30th; she lay in the stream. She left Wei-hai-wei October 26th, 1900, and arrived at Woosung, October 28th; left Woosung, October 29th, and arrived at Hongkong November 1st. She lay in the stream at first, but afterwards went into dock at Kowloon. She left the latter berth and cleared for Durban on November 7th, 1900. Her further history is tabulated below:—

Left.	*Arrived.*
1900.	1900.
Kowloon Dock, November 7th	Durban, December 3rd; lay in the stream.
Durban, December 7th..........................	Capetown, December 10th; lay alongside at South Arm.
South Arm, December 14th....................	Graving Dock, December 14th.
Graving Dock, December 21st............ ..	Coaling Wharf, December 21st.
Coaling Wharf, December 24th	Anchorage in stream, December 24th.
Anchorage in stream, December 27th ...	South Arm, December 27th; lay alongside.
1901.	1901.
South Arm, January 4th	Anchorage in stream, January 4th.
Anchorage in stream, January 11th	South Arm, January 11th; lay alongside.
South Arm, January 12th	Port Elizabeth, January 14th; anchored in stream.
Port Elizabeth, January 14th................	East London, January 15th.
East London, January 16th..................	Durban, January 17th; anchored in stream.
Durban, January 19th	Capetown, January 23rd; anchored in stream.
Anchorage in stream, January 29th	South Arm, January 29th; lay outside the s.s. "Juanita North," across which vessel traffic with the shore was carried on.
South Arm, January 31st	Coaling Wharf, January 31st.
Coaling Wharf, February 1st	South Arm, February 1st; lay alongside.
South Arm, February 1st	Albany, W.A., February 20th; anchored in stream; took coal from a lighter.
Albany, February 22nd	Sydney, March 2nd; was arrested at the Boarding-station.

62. There is no reason for referring further to any of the ports touched by the "Antillian" during the fourteen or fifteen months which preceded the date of her departure from Capetown for Australia; there is an apparent possibility of her having acquired the infection of plague, but nothing occurred during her second term of service on the South African coast (of three months) to raise a suspicion that she actually had done so. On the other hand, although at the date she left Capetown that port was not known to be infected with plague, remarks published by the Director of the Bacteriological Institute, Cape Colony (Dr. A. Edington),[*] leave no room for doubt that the rats infesting the South Arm of the Capetown docks had been dying of some epizoötic disease before February 5th; and, since the prevalence of disease among them had become known by that date at latest, it is almost certain that they had begun to suffer at least a fortnight or three weeks before. Now, from the log of the "Antillian" it appears that this vessel had lain alongside at South Arm during 1901 on January 11th, January 20th, and February 1st.[†]

63. The "Antillian" lay at Albany for twenty-four hours on February 21st and 22nd; she anchored in the stream, and received coal from a lighter which came alongside. As plague has occurred in Western Australia it is necessary to point out that the first case in that State in 1901 (but see Table VII, p. 11) was notified on March 1st, and was that of a man who had died at Perth—that is to say, this death occurred five or six days after the "Antillian" had left Albany. The latter is not near Perth; it is a small town on King George's Sound where there is an excellent harbour, and lies 245 miles south-east of Perth, with which, however, it is connected by rail. Other cases subsequently occurred at Perth, and more at some other towns; but no suspicion of plague has ever attached to Albany either in its people or in its rats; it has already been noted above that mortality among the ship's rats was discovered on the day of departure from this port.

64. The "Antillian" was returned to service 13 days after her arrest[‡]; and 35 days after arrest sailed for Capetown, carrying 527 troops and their horses. No suspicious illness occurred on the voyage. She is the only vessel entering the port of Sydney on which either plague-rats or cases of plague in man have been discovered.[‡]

65. But the mode in which plague is diffused by sea is not always as clearly demonstrable as in the foregoing instance; and this the following case well exemplifies.

The Case of the Barque "Eulomene" (Case 72).

66. The four-masted barque "Eulomene" left Liverpool October 12th, 1901, carrying a crew of 34, and a general cargo. She arrived at Sydney January 15th, 1902 (Case 4), and reported one death from dropsy during the voyage; she was admitted to pratique the same day. She lay in the stream until January 21st, when she went alongside Federal Wharf and discharged cargo; 800 tons, consigned to Newcastle, were retained on board. On February 26th she left Federal Wharf and lay in the stream till March 6th (Case 49).

67. Rats from Federal Wharf had been examined in the laboratories on November 22nd and 23rd, and from Federal Bond on November 23rd, 25th, 26th, and 28th, 1901; between March 5th and April 15th, 1902, 186 rats were collected on the wharf on 25 days, of which 45 were examined in the laboratories; in all cases the result was negative, and there was no history of unusual mortality among the rats at this wharf.

68.

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[*] The *Lancet*, June 8th, 1901.

[†] It is necessary to note here that Dr. Edington did not succeed in collecting any rats at South Arm docks for six days after the search commenced; that the carcase of a rat which had recently died was delivered to him on the seventh day; that he found that this rat had died of an infective disease; and that while he was unable to name this disease he considered it was not plague. Manifestly little importance attaches to this failure to identify disease in a single carcase.

[‡] Contrary statements contained in the Local Government Board's "Reports and Papers on Bubonic Plague, 1902," are erroneous.

68. On March 6th, before her departure for Newcastle, the vessel was handed over to the Fumigating Staff, under Captain Tait, in accordance with the Order in Council of November 21st, 1901; it was subsequently reported that this fumigation was very thorough, and that after being detained not less than six hours under sulphur, she had sailed. The hatches were opened at sea, and the holds were searched for dead rats as soon as they could be entered by the crew; the Master said that many fresh carcases were found, as well as some rats which were alive, but stupefied; altogether about 40 were thrown overboard. On arrival at Newcastle, on March 7th, the "Eulomene" went straight to the Dyke and shipped 500 tons of coal; on March 8th she went alongside at Queen's Wharf and discharged the 800 tons of cargo; she left Queen's Wharf March 20th and made fast to No. 1 Dolphin, Stockton.

69. On March 17th (or ten days after arrival) F. J., 43, ship's steward, was taken ill, and was attended on board by a private practitioner, under whose direction he was removed to the general hospital on shore. On March 19th his case was reported as suspicious, and the Medical Officer of Health for the Hunter River Combined Districts (Dr. Robert Dick, M.B., D.P.H.) was directed to examine him. On the 20th Dr. Dick reported that smears made with liquid withdrawn from the right axillary bubo which the patient exhibited showed a few micro-organisms resembling *b. pestis*, and that agar-tubes inoculated with the same liquid had yielded pure cultures of *b. pestis*, after 24 hours' incubation; he subsequently further reported that a guinea-pig inoculated with the liquid had died of plague, as ascertained by the usual processes. These results, at Dr. Dick's request, were checked, as far as possible, and were confirmed, in the Departmental laboratories.

70. The Port Health Officer (Dr. R. U. Russell) was at once directed to place the vessel in quarantine, and to cause her crew (who on her arrival at Newcastle numbered 22) to be collected on board with assistance of the Water Police; on the 21st she hauled off into the stream. A further fumigation with sulphur was carried out, and a very thorough search for rats afterwards made by the Quarantine Staff, under Dr. Russell's supervision. About 20 desiccated carcases were found, but only two recently dead rats and one mouse; the latter were examined by Dr. Dick and furnished no evidence of plague. All on board remained in good health, and after 5 days detention the "Eulomene" was admitted to pratique. At the same time the 800 tons of cargo landed at Newcastle were traced to various bonds and stores, some in towns at a considerable distance; they consisted of cases of hardware, crates and casks of earthenware, cases of whisky and beer, bales of paper and of other such goods, many of which were likely to harbour rats. It was found that some of these packages had been opened already; others were opened with precautions, under supervision, but it was reported that no rats were found in any instance.

71. In the meantime the patient had been removed from the general hospital to the Maritime Quarantine Station at Stockton. His illness was not very severe, and he was able to give the following information which, on the whole, was corroborated by enquiry of the Master and some members of the crew. He said that while the ship lay at Sydney fresh meat and vegetables were furnished by a ship's butcher in Erskine-street. A bag or two of potatoes were supplied at a time, and were kept on board in his store; on several occasions, on putting his hand into the bags, he encountered rats which were stupid or sluggish, so that he had had no difficulty in destroying them, and had not been bitten by them. He said he had thus found 6 rats at least, on different occasions, and for the last time some few days before leaving Sydney. On being questioned the butcher admitted that he had got some of the potatoes at all events (he was reluctant to furnish information) from a produce salesman trading at Nos. 61–63 Sussex-street. At this store no plague rats had been found, and no case of plague had occurred; but at No. 41 (ten doors away) plague rats were got on February 18, 19, and 20; at the Union Company's wharf on February 19; at the North Coast Co.'s wharf on February 25; dead rats had been seen by officers of the Department at Campbell's produce store, 49–51 Sussex-street, and Case 42 occurred in a man employed there as a carter, who was attacked February 27; and plague rats had been got from Huddart, Parker, and Co.'s wharf on February 28: all of these premises being close together on the same

side of Sussex-street—that is to say, on the eastern side of Darling Harbour—as the premises of the produce salesman who sold the potatoes to the ship-butcher, who supplied them to the "Eulomene" while she lay at Sydney.

72. The above are the facts of this case, as far as they could be ascertained; they must not be taken for more than they are worth. For instance, it is quite possible that at some time or other before March 5, during the "Eulomene's" stay there, the Federal Wharf may have harboured plague rats, of which specimens were secured from other wharves at no great distance. The ship's rats may also have become infected during her long stay at a wharf in an infected neighbourhood in other ways, as exemplified by the steward's account, which latter seemed trustworthy as regarded the important points. Secondly, after the first fumigation at Newcastle, twenty desiccated carcases of rats were found. Now these carcases hardly could have been killed by the first fumigation (March 6), because the interval between it and the date on which they were discovered (March 22) was not long enough for desiccation, or, as it was described, mummification. Did these desiccated carcases represent the result of a foregoing epizoötic which occurred while the ship lay at Sydney, or did they represent merely the turning out of gradually accumulated carcases from parts of the ship rarely cleansed? There is no reason to doubt that the two rats and one mouse found after the second fumigation represented all that the ship then carried alive; both the fumigation and the subsequent search were most thoroughly carried out, and the result was accepted as proof that she was not then infected, so that she was forthwith released from quarantine. The fact that one only of the twenty-three persons on board was attacked is not evidence that the vessel had not been the subject of general infection; our experience has shown that when the infection is present, as proved by the occurrence of one case, very often no further cases occur. But the one person infected in this instance was the steward, and according to his account he had been specially exposed. Was he infected directly from the sick rats he took out of the potato bags? This cannot have been the case, because he was not attacked until ten days after he had left Sydney, and the last occasion on which he had caught a rat was several days, as he said, before leaving. For similar reasons he cannot have been otherwise infected at Sydney, for he had not been ashore there for nine days before he arrived at Newcastle, or nineteen days before his attack; and he was not infected on shore during his stay at Newcastle, because there had never been plague there, and the solitary case which afterwards occurred under circumstances which require separate description, was not attacked until August 7, or about five months afterwards (see page 49). He must have been infected on board his ship; and, as he exhibited a bubo, he was infected by inoculation; that being so, it is unlikely that he received the infection earlier than March 14, or three days before his attack. Whence was he inoculated? The choice seems to lie between contact with deposited infection and inoculation by a parasite. As to the first, the infection might possibly have been deposited by the sick rats he caught; but in that case it must have survived in virulent form for ten days at the least, or for about fifteen days (namely, from the date of the ship's departure from Sydney, or from that date a few days earlier on which he had seen the last of the sick rats); besides which the cuticle of the extremity had not recently been broken (see Further Observations on the Mode of Infection, p. 65). Certainty cannot be reached—I may almost add, of course; for although epidemiological problems are resolved by induction from collected cases, it often happens to be impossible to show that a particular instance exemplifies the solution. I conclude, therefore, by pointing out that these notes suggest an analogy with certain occurrences of yellow fever on board ships.

73. The "Eulomene" sailed from Newcastle for San Francisco, where she arrived July 24. A rumour was heard that her master was ill on arrival, and subsequently died, of plague. By favour of the United States Consul the Medical Officer of Health received a copy of a report made on the case to Surgeon-General Wyman, Public Health and Marine Hospital Service of the United States, in which it was clearly shown that the disease was beri-beri, and that there had not been any suspicious illness of any character during the voyage of the vessel to that port.

Part II.—Mode of Spread.

SUBDIVISION OF THE AFFECTED DISTRICT INTO AREAS.

74. I now enter on a description of the mode in which the epidemic spread. This has been designed so as to place the reader in the same position as those who watched the events as they occurred from day to day, as far as possible; and, in order to make it more easy to grasp, the parts of the city in which indigenous cases of plague were met with have been divided into areas, to which the following names have been given (see Diagram II):—

Area.	Area.	Area.
South-central.	Central.	North-central.
Paddington.	Darling Harbour.	South-west-central.
Chippendale.	Woolloomooloo.	South-east-central.
Alexandria and Waterloo.	Camperdown.	Pyrmont.

75. As a rule, the description of the epidemic on each area dealt with has been completed, a plan which has obvious drawbacks; but the alternative, which is to describe the cases in their time-relation, could lead to nothing but confusion, and may be dismissed as impracticable. The description of the South-central area alone has been interrupted to admit that of the sub-epidemic on the Paddington area. No "area" has been assigned to 4 isolated cases which are adjudged to have been infected at 4 widely separated places.

76. To describe all the cases, and even all the areas, would involve a good deal of repetition owing to general similarity of the facts; some have therefore been selected. They constitute a large majority; but, in an inquiry of this kind, it is important that the reader should have some means of judging whether anything of real importance has been omitted. For this reason a Table has been inserted in the Appendix, in which every case is mentioned under its serial number, and a reference given to some of the paragraphs in which those which have been described may be found. This Table also shows the date of attack in each case, the 86 adjudged places of infection for 113 of them (that is to say, the number which remains after 1 case excepted, and 25 cases in which the place of infection remained undetermined, have been deducted from the 139 cases in which the epidemic consisted), and the area within which 82 of those places stood (see par. 75, end).

SOUTH-CENTRAL AREA.

77. The following Table shows the cases which occurred on this area:—

TABLE IX.—Showing the serial number, date of attack, adjudged place of infection, and residence of the 8 cases which occurred on the South-central Area.

Serial No.	Date of attack.	Adjudged place of infection.	Residence.
1	Nov. 4, 1901 ..	Exton's Store, Hay-street ...	Alexandria.
4	Jan. 12, 1902 ..	285, Castlereagh-street ...	The same.
16	Feb. 9, 1902 ...	376, Pitt-street	,,
93	April 3, 1902 ...	137, Liverpool-street	Marrickville.
112	,, 27, 1902 ...	26, Campbell-street	The same.
113	,, 30, 1902 ...	59, Goulburn-street	,,
117	May 3, 1902 ...	26, Campbell-street	,,
126	,, 15, 1902 ..	26, Campbell-street	,,

Case 1.

PLAGUE REPORT 1902

"DIAGRAM II"

Nº of Lith. 03 731 D.

PREPARED FOR THE DEPARTMENT OF PUBLIC HEALTH

MAP OF THE

CITY OF SYDNEY

AND

ADJACENT MUNICIPALITIES.

SCALE

1903

THIS DIAGRAM SHOWS THE ADJUDGED PLACES OF INFECTION FOR 113 CASES OF PLAGUE, BY 86 BLUE SPOTS. IT ALSO SHOWS THE ARBITRARY BOUNDARIES OF THE AREAS WHICH, FOR CONVENIENCE OF DESCRIPTION, HAVE BEEN ASSIGNED TO THE DIFFERENT NEIGHBOURHOODS IN WHICH THOSE PLACES STAND, BY BROKEN BLUE LINES.

Compiled, Drawn and Printed at the Department of Lands, Sydney N S W Augᵗ 1903

Seamen's Hospital Society
TROPICAL
DISEASES
19 JUN. 1923
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Case 1.—R.B., m., aged 17, not inoculated, was suddenly attacked with headache and rigors after reaching his place of employment on the morning of 4th November, 1901. He immediately returned to his residence, and lay there under care of his club surgeon until 8th November; he was then transferred to Prince Alfred Hospital. His case was reported to the Department on 14th November; he was visited by the Assistant Medical Officer of the Government (Dr. R. J. Millard, M.B., D.P.H.), and was removed to isolation the same day. His removal was determined by purely clinical considerations, for the morphological test which was applied to liquid abstracted from the right femoral bubo he exhibited failed to reveal the bacillus of plague; but the cultural and inoculation tests which were begun at the same time yielded positive results in due course. Ultimately the patient recovered.

78. R.B. resided with his family of 6 persons in a two-storied brick cottage at Alexandria, some 2 miles away from his place of employment. These premises were very carefully examined on the day his case was reported, but nothing of importance was discovered; they were in fair general repair, maintained in average good order, and furnished no evidence at all of infestation with rats. No illness occurred among the rest of the household. He was employed, along with three other men, at a produce store in Hay-street, in the City of Sydney, which will be further referred to as "Exton's store," and these premises were also examined as soon as attention had been directed to them by his case. They were found to be one of 13 houses on the frontages of a very small block which was occupied in large proportion by gasometers, the extensive and lofty building of a "universal provider," and a church. Eleven of them were used as produce stores, one was a seedsman's, and one a small hardware store; that is to say, they were chiefly used in ways most likely to attract rats to them. They had behind them a small common yard, in which four of these traders, who were Chinese, had erected stables and feed-rooms. Exton's premises were in fairly good repair, but offered abundant evidence of infestation with rats; and on raising the wooden floor 69 carcases were found. Of these 68 were too putrid for any useful examination, but one was quite fresh; it afforded the usual microscopical, cultural, and inoculation evidence of plague. This animal, then, had lately died of plague; and it is a very reasonable assumption that the other 68 had also died of that disease at somewhat earlier dates. No case of plague occurred among R. B.'s 3 fellow-labourers at the store, and none was heard of among the persons who had frequented it, for no further case came to notice during the ensuing 5 weeks.

79. The cleansing-staff immediately went through the block, and in the course of their work discovered 18 more putrid carcases. These are said to have been found outside buildings, for the most part, at least, but no note on this point was made at the time. No other of these houses, however, afforded evidence either of such infestation as was discovered at Exton's, or of any unusual mortality. There are here three noteworthy points: Our general experience as far as it has gone shows that only a moderate or even small proportion of adjacent premises may be infested with rats (apart from question of plague) although from their structural state and use nearly all of them appear equally likely to be so; of which a further and detailed instance will be given below. Further, it appears that often the epizoötic is largely confined to the rats inhabiting particular premises, and at any one time probably affects but a small proportion of the total rats in the district. Secondly, from both epidemics we have evidence of establishment of centres of infection by a mode of transportation from the local *fons et origo* which does not cause infection of the traversed interval, and of slow and irregular spread of the epizoötic from them; while many adjacent buildings might at the same time harbour a plague-stricken horde, on the whole this appears to be seldom the case. Lastly, it will be observed that but one carcase was found which was in a state to admit of its bacteriological examination; all the others were advanced in putrefaction. Our general experience is that while dead rats are often found in a number which indicates some unusual cause of the mortality on premises to which attention has been directed by occurrence of a case of plague in man, it is quite unusual to find them early enough to allow of demonstration of the nature of the disease of which they have died. We have been led by observation to consider that discovery of several carcases at about the same stage of putrefaction on premises where poison has not been laid, is good evidence of disease in epizoötic form.

80. Efforts were also made at once to ascertain the provenance of Exton's stock, and steps were taken to re-organise a rat-catching staff. As to the former, it was said that some of it came in by rail from country districts in this State where, of

course, there was no plague; but the greater part came in by sea, and was landed at the wharfs where this trade is chiefly carried on, those, namely, on the eastern shore of Darling Harbour. This portion chiefly arrived from South Australia, Tasmania, &c., &c., and it was said that none had been received by him from Queensland.

81. The rat-catchers got to work on 16th November, and on 17th November they made their first return. They were instructed to attach the addresses at which they had caught the rats to the carcases, and to hand them in to a foreman, who recorded them, each morning. This staff was further instructed to forward to the laboratory the bodies of all rats apparently sick on discovery, and the bodies of all which were gathered on premises where there had been unusual mortality among them. Carcases thus selected were examined in the laboratory; but the method of selection was imperfect. It was not until 1st April that all rats taken by this staff were handed in at the laboratory and systematically examined there.

82. The neighbourhoods in which the staff worked during the days now under notice were the line of wharves already mentioned, the buildings from the head of Darling Harbour towards Exton's store, from the latter westerly along George-street, and additionally along the line of that gutter or natural surface depression which ascends from George-street in a southerly direction to the Newtown-road. To speak for the present of the first 10 days of this search only, 1,657 rats were caught at 28 wharfs, and at 115 different premises, which included many produce stores, hotels, eating-houses, and provision shops, on or about the line above indicated; 117 were selected and were forwarded to the laboratory. Thus the rats on the area which there was most reason to suspect (in part from our former experience) were examined. It would have been better had all those caught been delivered at the laboratory; but it must be remembered that had this course been taken, the examination would not (and it never could) have amounted to more than a sampling—to examination, that is, of the rats in some of the innumerable houses which stood on the area referred to. Further, selection of the buildings visited was largely governed by willingness of the occupants to admit the rat-catchers at night.

83. On the second day (18th November) of the search a plague-rat was detected among those referred to the laboratory. It had been collected at Howard Smith & Co.'s wharfs, and at that one of them which is called the Brisbane Wharf (see par. 49), although it is understood not to be exclusively used by those vessels of this firm's fleet which trade between Sydney and Brisbane; they are wharves at which much grain and produce are handled, and adjoin those wharves at which Exton's stock in part was landed—the detected infection of this Brisbane wharf betokening, of course, probable infection of other wharfs in its immediate neighbourhood.

84. No other plague-rat was found until the ninth day of search (25th November). A second produce dealer, named Jones, then reported that the rats which infested his premises at 84, George-street West (about 45 chains westerly from Exton's) were dying in numbers. The store was at once closed and searched; no less than 154 carcases were discovered, and 35 living rats were killed. Here, it seems, the search was made quite early in the outbreak, and before the animals had recognised the expediency of leaving the premises; and it was easy to demonstrate that plague was the cause of the mortality. No case of plague occurred among the persons employed or living at this shop nor, it is believed, among those who must have frequented it. Then on the tenth day of search (November 26) a plague-rat was handed in by the Departmental staff, which had been taken on premises at the corner of Cleveland and Abercrombie streets, towards the head of the surface-depression already referred to, and about 22 chains southerly from Jones' store. They included a greengrocer's shop and a stable. There were abundant signs of recent infestation by rats in considerable number, but no carcases were discovered nor any live rats. It was noted that the premises were filthy, the yards being largely occupied by fowls, ducks, geese, and dogs. A ton of chaff, bones, and rat-rubbish was removed from under the floor of the feed-room, and the whole premises were in such a state of dilapidation that the Local Authority was required to apply for a closing order and for their demolition. No

case of plague occurred among the persons inhabiting these premises, nor among any casually connected with them as far as could be learned. No note was made as to the source at which horse-feed was procured; this may have been Jones' store, which was but a little over a quarter of a mile away.

85. Laboratory examination of rats continued in a manner which will be summarised and commented upon at a convenient place in this description, without revealing any others infected with plague, until the next case in man had occurred about five weeks later.

Case 2.—J.E.D., m., aged 37; had been inoculated at Rockhampton, Queensland, early in 1900 (see par. 28); married, four children. He was suddenly attacked on December 8, during the forenoon, with a sharp pain in the left groin, where femoral and inguinal glandular swellings subsequently developed. He lay ill at his residence in Spring-street, Waverley, about 3 miles away from his place of business and the other places hitherto mentioned, under private care until December 10, when his case was notified. The diagnosis was at once made from clinical signs; subsequently morphological, cultural, and inoculation tests all yielded positive results. His condition at the time of discovery forbade removal, and he died December 11 after an illness which had lasted sixty-five hours.

86. J.E.D. was a druggist's assistant. He had arrived from Rockhampton, Queensland, about two months before his death; no case of plague had been notified at Rockhampton for 10 months before his departure (or on 11th October, 1901); his wife said she had received a one pound note from her brother at Rockhampton since her arrival at Sydney, but that deceased had known nothing of it and had not seen it; the case of plague which was notified at Rockhampton next after the one just mentioned was ascribed to 11th February, 1903. His place of residence was in fair general order and repair; it stood in a suburb which has never yielded any other case, and it offered no traces at all of infestation with rats. The family of 6 persons, among whom no illness occurred, was entirely unacquainted with Case 1. He was employed by a firm of wholesale druggists at their premises in the city of Sydney. The firm said that poison had been laid ever since Case 1 had become known, and that 72 carcases had been found and destroyed. A good many more, in advanced stages of putrefaction, were afterwards turned out in course of cleansing, but no live rats were seen, and no evidence of plague was obtained. Such mortality from poison is quite unusual. There were here about 300 workmen, among whom no illness occurred. But D., regularly employed during the day at this establishment, was also employed in the evening by a benefit society, and on this duty he went to the dispensary, which stood in Castlereagh-street, at a point not more than 11 chains distant from Exton's store (Case 1). On examination the dispensary was found to be very well constructed, clean, and free from evidence of infestation with rats; and none of the subsequent cases of plague were traced to connection with it.

Evidence of Diffusion of the Infection.

87. The rat-search continued without revealing any plague-infection until after a further interval of thirty-five days. The third and fourth cases in man happened on January 10 or 11 and on January 12. The former was the first of a sub-epidemic which occurred on what has already been referred to as the Paddington area; the latter was found in the immediate neighbourhood of the dispensary building mentioned in connection with Case 2, and consequently on the South-central area. Cases 3 and 4, therefore, furnished the first clear evidence that the infection had become diffused. The sub-epidemic which followed on Case 3 afforded an unusually distinct (but far from solitary) example of transport of the infection over a considerable tract which either entirely escaped, or suffered only in part at a much later date and, plainly enough, from infection otherwise communicated to it; and I interrupt the account of the South-central area to describe it here, because it was altogether confined to a remote and circumscribed area, and furnishes a most useful type of the course of the epidemic as a whole.

The Paddington Sub-epidemic.

88. The table below shows the serial number, initials, sex, age, date of attack, and address of the patients whose cases constituted this sub-epidemic, as well as particulars concerning two undiagnosed cases which, I have little doubt, were also cases of plague. These latter are unnumbered (see Diagram III).

Table X.—Showing the serial numbers and dates of attack of the nine cases which constituted the Paddington sub epidemic, as well as of two undiagnosed cases connected with them :—

No.	Name.	Sex.	Age.	Date of Attack.	Address.
3	E.A.G.	F.	50	January 10 or 11	145, New South Head Road.
...	G.B.	M.	35	,, 13	18, South-street, New South Head Road.
...	J.E.G.	M.	69	,, 16	35, Gurner-street, Paddington.
5	E.G.	F.	21	,, 16	145, New South Head Road.
6	M.C.	F.	43	,, 19	147, ,, ,,
7	R.V.	F.	10	,, 19	115, ,, ,,
8	J.C.	F.	72	,, 20	147, ,, ,,
13	M.A.	F.	38	February 7	163, ,, ,,
14	J.H.	M.	59	,, 10	192, Albion-street, Surry Hills.
16	J.G.	M.	24	,, 10	312, Glenmore-road, New South Head Road.
17	P.B.	M.	12	,, 11	217, New South Head Road.

89. These cases came to light in the following way : On 14th January, M. C. (Case 6), who at that date was in apparent good health, reported that rats were dying in numbers at her residence, 147, New South Head Road. Thereupon the rat staff was directed to secure specimens from her cottage and from its immediate neighbourhood. No rats were caught that night, but the rat-catchers reported that the rats were dying at No. 149 (next door) also ; it was also mentioned that Nos. 145, 147, and 149 were one-storey brick cottages, identical in construction, and at a later date it was ascertained that the space under the floors of all three was continuous, and open to the rats which infested any one of them. No. 149 stood at the corner of Glenmore-road, and was occupied by R. Goff, junior, as a produce store. He said that the rats on his premises had been dying in numbers for about 10 days past (that is to say, from about 4th January). M. C. said she had seen sick, as well as dead, rats in her kitchen and laundry, and the occupants of all three cottages were at one in saying that although they had formerly been very much troubled with rats, none had been seen alive "for the past few days." On the morning of 16th January, the rat staff handed in one carcase which, on examination, was found to be free from disease ; however, they had removed three carcases from the yard of No. 147, and one from No. 145, all too much decomposed for examination, and had noted an extremely offensive smell on all these premises, as though dead rats lay concealed. Lastly, when the premises came to be taken in hand by the disinfecting staff, on 20th January, it was found that, although there were everywhere abundant traces of infestation with rats, there were none pointing to their quite recent presence (fresh dung). Ultimately no plague-rats were taken on these premises, and none were collected from any part of the infected area until many days afterwards.

90. Illness among the inhabitants of these three cottages was first discovered through report, on 19th January, that M. C. (Case 6) was lying ill at No. 147. It was then found that E. A. G. (Case 3) had been attacked eight or nine days earlier, and had been lying in bed at No. 145 in consequence, at the time the rat-search was going on. Comparative mildness of her illness (which, nevertheless, had compelled her to take to bed and to stay there) led to its having been thus concealed, or, rather, not mentioned. E. A. G. (Case 3), having been seized, on 10th or 11th January, E. G. (Case 5), in the same house, was attacked on 16th January, and M. C. (Case 6), in the cottage next door, on the day of notification, 19th January. R. V. (Case 7), who lived fifteen doors away, at No. 115, was attacked on the same date, and J. C. (Case 8) was attacked at No. 147, on 20th January. But there had been two other deaths in connection with these premises, which I have little hesitation in ascribing to plague, although this disease was not recognised as the cause at the time they occurred. The facts were as follows :—

Undiagnosed Case A.—J. E. Goff, senior, age 69, labourer. Was father of J. Goff, of 149, New South Head Road, and regularly worked at the produce store. He resided at a considerable distance away, in a plague-free neighbourhood. He arrived at the store at his usual hour on January 16, having been in good health until that date, but complained of feeling unwell; about 10 a.m. his son took him home, and two hours later he died. By direction of the Coroner, his body was inspected by a medical man, who reported that his death was due to syncope from heart disease. I ascertained that this opinion was based on a statement made by deceased's family that he had latterly been breathless on slight exertion, and on observation of slight œdema about the ankles; further, the gentleman referred to, who had both clinical and *post-mortem* experience of plague during the former epidemic, said he thought he could hardly have overlooked the signs of that disease had any of them been present. This may be readily conceded; and yet it appears to me probable that plague in one of its less usual, but not uncommon forms, in which all external signs are wanting, may have been the true cause of death.

Undiagnosed Case B.—G.B., a labourer, aged 35, lived in South-street (see Diagram III). He was an idler who was in the habit of doing odd jobs for R. Goff, junior, and when wanted was usually to be found hanging about the latter's store. He had been drinking from 11th January to 13th January, and thereafter had suffered rather severely from diarrhœa and vomiting. My informant first saw him on 17th January, and then noted a temperature of 102°; dyspnœa, but no physical signs in the lungs; heart's action very irregular, heart sounds feeble, pulse weak; no glandular enlargement; no albumen in urine; a boil on the buttocks. The patient died an hour or two after these notes had been made, and the cause was not assigned to plague at the time; but two or three days afterwards my informant heard of some of the circumstances now being described, and at once revised his opinion.

91. All of these persons were quite unacquainted with Cases 1 and 2, but there had been personal communication after commencement of illness between Cases 3 and 5 and Cases 6 and 8, as well as between the two households. Case 7 was unacquainted with the members of those two households, but was in the habit of visiting Goff's store to make purchases; her parents said that she had last been there "a few days" before she fell ill.

92. An interval of 19 days followed on the attack of Case 8 (20th January) during which no case of plague, nor any which caused suspicion of plague, occurred on this area, (nor, indeed, anywhere else until the seventeenth day); then the case of M.A., housewife, aged 38, was notified the day after her seizure on 7th February; morphological and cultural tests yielded positive results. She lived at 163, New South Head Road, seven doors from the produce store, though, on account of the intervening Glenmore-road, rather further than the space of seven houses away. She had no acquaintance with any of the foregoing patients. She lived in a brick house which was in average condition; but the occupants said that they had been much troubled by rats, and the disinfecting staff reported many rat-holes in the internal woodwork, as well as through the foundation walls, though no live rats nor any carcases were found. But the landlord had already been appealed to on this score, and on 7th February he had caused the ground floor boards to be taken up; quantities of rat-rubbish had been taken from the underspace, as well as two putrid carcases. It is to be noted that a carrier lived next door where he kept two horses. Three days later the following case was notified from a distant neighbourhood:—

Case 14.—J.H., house-painter, aged 59. Suddenly attacked on the morning of 10th February, after going to work, with headache, diarrhœa, abdominal pains, and fever; he exhibited a solitary, left femoral, bubo. Morphological, cultural, and inoculation tests, all yielded positive results. Recovered; duration of illness, thirty-five days.

93. J.H. lived at 192, Albion-street, Surry Hills, about a mile distant from the Paddington area, and in a district from which no cases had been reported for diagnosis. The house was one of a brick terrace; it was in good repair, and well kept; the inhabitants said it had no rats, and the disinfecting staff reported that it was entirely free from traces of infestation. No other case occurred in this household, which consisted of twelve persons. Judged in the usual way, it appeared that J.H.'s residence could not have been the place of his infection. But his occupation led him into other neighbourhoods, and into other premises; and when his movements came to be inquired into it turned out that he was the man whom M.A.'s landlord had employed to raise the floors at 163, New South Head Road, and who had removed the rubbish and the dead rats from beneath them on 7th February. This is a very important and interesting case, to which there will be occasion to refer in another connection; in the meantime it need merely be pointed out that the patient received the infection by inoculation in the left lower extremity, in which there were no visible wounds or abrasions, and that he fell ill a little less than seventy-two hours after he had begun his work at No. 163.

94. The occurrence of Cases 15 and 17 on 10th and 11th February concluded this sub-epidemic; it is not necessary to mention many details of them. J.G. (Case 16) was carter for another produce dealer, and lived quite close to Goff's (see Diagram III);

no dead rats were found either at his place of residence or of employment. P.B. (Case 17) was a schoolboy, who lived at a public-house at the corner of Maclean-street. His residence showed the signs of moderate infestation with rats usual on public-house premises, in certain parts of it, and no more; no dead rats were found, nor had the inhabitants seen any; but on 15th February a plague rat was collected from No. 10, Maclean-street, a cottage three or four doors from the public-house. These two patients were said to have had no communication with any of the previously infected households.

95. In order to complete this account it is necessary to review the efforts made to ascertain the state of the area as to infection of its rats. It carried only 163 premises altogether. As has been already mentioned, the rat staff had been directed, on 14th January, that is to say as soon as mortality among the rats which infested Nos. 145 to 149, New South Head Road, had become known, to search those cottages and the immediately adjacent roads, lanes, &c.; and the result had been to show that the rats referred to had suffered from sickness and had died, but had by that time gone away. But the search, which should have extended to slightly more distant streets, was not prosecuted with vigour until after occurrence of Case 17. Thus, down to 12th February only 23 rats, taken on 12 premises, had been brought in; but between that date and 17th February as many as 129 rats were collected by trapping at 60 different premises. The result of this more energetic and more systematic hunt was that on 14th February one plague rat was taken in a builder's yard across New South Head Road, immediately opposite to Goff's store; on the same date another at No. 155, New South Head Road, also a produce store, on the same side as Goff's, but separated from it by Glenmore-road and the premises at the corner opposite to Goff's; while on 15th February a third plague rat was taken, as already noted, at 10 Maclean-street. There is here sufficient evidence of dissemination of the infection of plague among the rats of the neighbourhood; nevertheless I note the infrequency of the disease among the total rats brought in to the laboratory, and reserve this point for the present.

96. The whole of the area affected was taken in hand by the cleansing staff, and thoroughly scavenged, many out-buildings having been pulled down and burnt, and some premises which were unfit for human habitation closed and demolished. The disease did not spread beyond the limits, which include about 16 acres, shown by Diagram III, partly, no doubt, in consequence of the measures taken, but in part also owing to large tracts of park or garden ground, and of vacant lands, by which it was more or less closely bounded to the north and west.

South-Central Area Resumed.

97. We must now return to the South-Central Area, and to Case 4, which was the next to occur upon it.

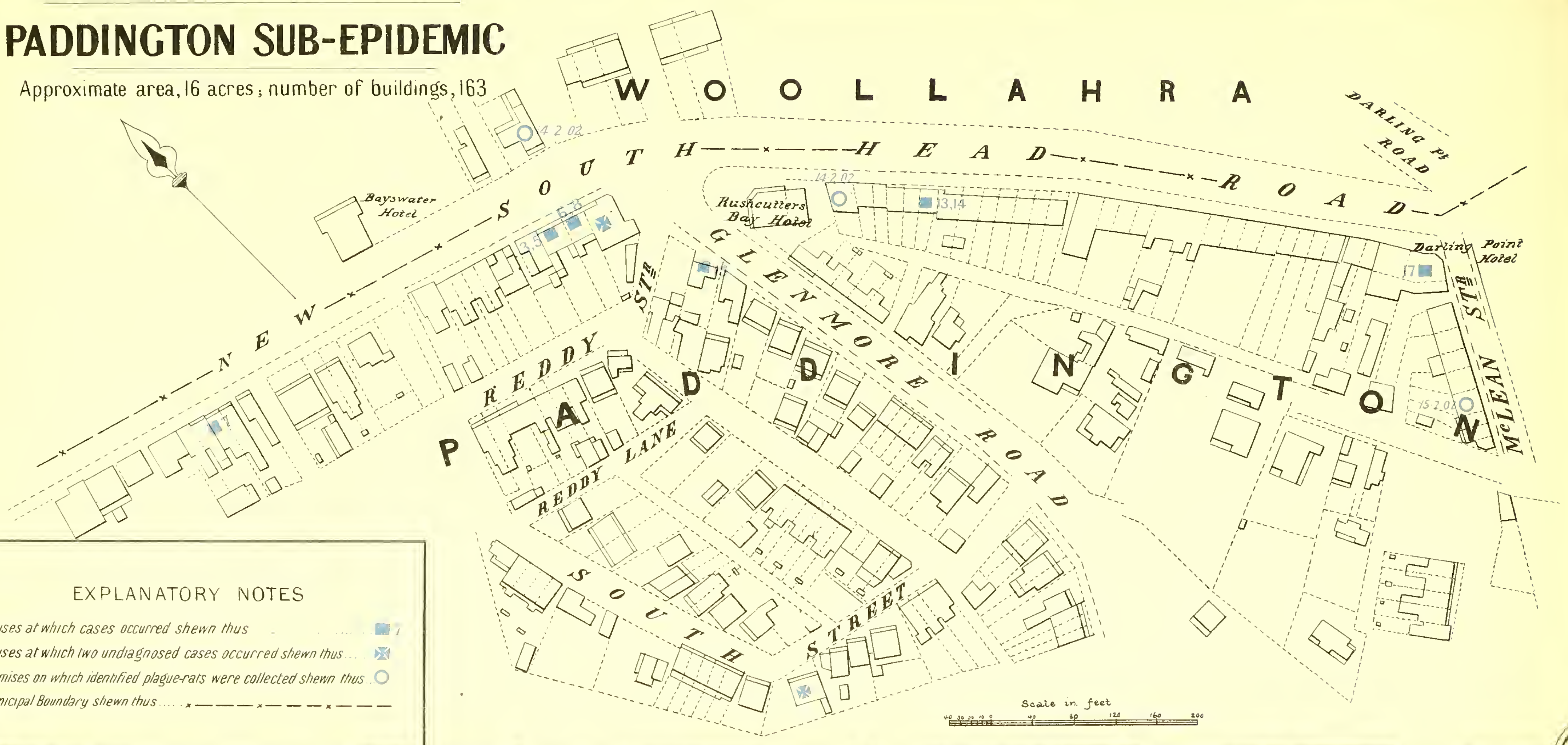
Case 4. V.U.E.V., m., aged 34, a publican, not inoculated, was suddenly attacked during the afternoon of 12th January with shivering, and at the same time discovered a small lump in his right groin, where an inguinal bubo subsequently developed. The morphological test applied to liquid abstracted from the bubo was negative; cultivation and inoculation tests yielded positive results in due course (on the third day of illness this patient's blood was, for some reason, submitted to the same three tests, all of which yielded negative results). Recovered; duration, fifty seven days.

98. The patient was unacquainted with any of the persons previously attacked. He carried on his business at the corner of Goulburn and Castlereagh streets, a point about 2 chains from the dispensary with which Case 2 was connected, and which stood in Castlereagh-street, and about 12 chains from Exton's produce store, where Case 1 had been infected two months earlier. About the beginning of December he had reported to his Local Authority that his premises were infested with rats, and said that soon afterwards he had counted 17 in his kitchen one night; later still he had found a dead rat, and about the same time there had been a very offensive smell, as though dead rats lay concealed, but no more were found. The other residents said at the time of inquiry that the house had been infested shortly before, but that they had seen no rats since the closing of a neighbouring restaurant. The disinfecting staff reported that there were no quite recent traces of infestation, and although traps were set, no rats were caught. There were seven inhabitants, among whom no further illness occurred.

Prepared for the Department of Public Health

PADDINGTON SUB-EPIDEMIC

Approximate area, 16 acres; number of buildings, 163



EXPLANATORY NOTES

Houses at which cases occurred shewn thus ■ 7
Houses at which two undiagnosed cases occurred shewn thus ⊠
Premises on which identified plague-rats were collected shewn thus ○
Municipal Boundary shewn thus — × — — — × — — — × — — —

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Compiled, Drawn and Printed at the Department of Lands, Sydney, N.S.W. 1903

99. Long as the intervals had been by which this case was separated from Case 2, and the latter from Case 1, it was yet taken to point in all probability to some obscure infection of the rats in the neighbourhood, and a house-to-house inspection of six small blocks, towards the centre of which V.U.E.V'.s public house stood was directed. They comprised in all 387 houses, of which 169 were occupied by Chinese; this being one of the small colonies of Chinese of which there are many in the metropolitan district. The greater number were modern buildings of good construction, in good order, and often of considerable size; but they included a proportion of ancient structures, much dilapidated and very ill-kept. The area was cleansed by a large staff of labourers, under direction of the Departmental staff of educated sanitary inspectors who made the survey. The latter reported that in all but the more recently erected buildings—and even on some of them too—there were more or less serious sanitary faults; while light and ventilation had been obstructed in very many instances by illegal roofing over of small yards and erection of temporary structures in the larger ones. When the premises were occupied by Chinese there was also evidence, internally, of serious overcrowding. The local authority was advised to apply for closing orders in respect of many of these buildings and to secure the demolition of some of them; and there was one small area in such a state that it was recommended to acquire possession of it and to run a new street through it. But no illness was discovered in the course of the survey, and no plague-rats. A fact which has importance in relation to general rat searches in any part of a city was brought out by the records; it was, that although a large proportion of the 387 premises appeared to be fit to harbour rats both from their structural state and from the purposes for which they were used, yet only 57 (or less than 15 per cent.) were found to furnish evidence of actual infestation at the time of survey.

100. No further case occurred on this area until 9th February (Case 16), which was notified from rat-infested premises of which the back yard abutted on V.U.E.V.'s yard, though separated from it by a high brick wall. Another occurred near by on 3rd April (Case 93) in a sempstress, employed at a furniture factory. Later, three other cases were met with in Chinese, who were attacked on 27th April, 3rd May, and 15th May (Cases 112, 117, 126—see par. 207); they were infected at Hop Lee & Co.'s produce store in Campbell-street, and a plague-rat had been caught six doors away from Hop Lee's on 22nd April. It seems most likely that these cases resulted from infection newly imported to this street, which, at that end of it, is almost entirely occupied by produce stores and a vegetable market, rather than by persistence of the infection associated with Case 1, which occurred quite close by, but nearly six months before. On 30th April another Chinese (Case 113) was attacked at 59 Goulburn-street, in the same neighbourhood. Lastly, on 1st June, Case 136 occurred on this area, but not near those last-mentioned; the patient was an idler, the place of whose infection remained undetermined, it being almost certain he did not contract his illness at his lodging. Here two notes may be made: The first is that as it has been shown that the infection can be conveyed *per saltum* (most probably to Exton's store, certainly to Goff's store), so it may be communicated to any neighbourhood repeatedly, as long as communication with any other infected spot is maintained. Secondly, in any long series of cases of disease a certain number will be met with in which the source of infection cannot be indicated with any certainty; and this is so far from being peculiar to plague that it is the case even with so easily traceable an infection as that of small-pox.

101. No further cases occurred on the South-central area. If the serial numbers are now examined it will be found that one case has been omitted from notice. This is Case 9. Attack occurred on 4th February; the patient was a newsboy who lived on an undefined area just north of the North-central, where he inhabited a dilapidated four-room cottage, near the northern end of Cumberland-street, which was infested with vermin; it had been infested with rats, but at the date of examination had for long been free from them. The place of this patient's infection remained undetermined; it was merely surmised that he might possibly have received it in calling for stock at the *Evening News* office, which was separated by a narrow lane only from Siddaway's boot factory on the Central area, at which Cases 34 and 43 were infected on 24th and 27th February, and where there was considerable mortality among the rats which infested it (see par. 217).

CHIPPENDALE AREA.

102. It is necessary here to describe only two of the cases which occurred on the Chippendale area, but the following Table gives a complete list of all of them:—

TABLE XI.—Showing the serial number, date of attack, adjudged place of infection, and residence, of the eight cases which occurred on the Chippendale area.

Serial No.	Date of attack.	Adjudged place of infection.	Residence.
	1902.		
10	February 5	Sportsman's Arms Hotel, 171 George-street West	The same.
12	„ 5	Fish and oyster saloon, 167 George-street West	„
37	„ 20	68 O'Connor-street, Chippendale	„
62	March 16	5 Chambers-street, Ultimo	„
82	„ 21	16 Dick-street, Chippendale	„
92	„ 29	16 Dick-street, Chippendale	„
102	April 18	89A George-street West, City	„
105	„ 20	66 O'Connor-street, Chippendale	„

103. Cases 10 and 12 were attacked on 5th February at 171 and 167, George-street West. These houses were about 11 chains distant from Jones's produce store, and on the opposite side of the road (see par. 84).

Case 10. T.C., potman, aged 42; place of residence and of employment, Sportsman's Arms, 171, George-street West. Suddenly attacked 5th February, afternoon; right femoral bubo; morphological, cultural, and inoculation tests, positive. Recovered.

Case 12. G.W., a fishmonger, aged 35; place of residence and of employment, a fishmonger's shop, 167, George-street West. Attacked 5th February; right femoral bubo; morphological test, positive. Recovered.

104. The premises were next door but one to each other, and it will be noticed that both were used in a way likely to attract rats to them. At No. 171, it was said that rats were plentiful both in the neighbourhood and about the public-house itself; but not that there had been any observed mortality among them. The yard was tar-paved and undermined; part of it was dug up and six putrid carcases were revealed. Three more were found at a gully communicating with an old drain which had not been removed when the premises were connected with new sewers; from this rat-burrows were traced, and dug out, which ran under the intervening house, No. 169, and passed into No. 167; a plague-rat was taken out of them, which was identified in the laboratory on 10th February. The disinfecting staff also killed three rats which were healthy. G.W. (Case 12) was employed and resided at No. 169; his house was not noted to have been greatly infested.

ALEXANDRIA AND WATERLOO AREA.

105. We now have to describe establishment of another distant, and apparently independent, centre in connection with a fourth produce store (see Diagram IV).

TABLE XII.—Showing the serial number, date of attack, adjudged place of infection, and place of residence of the eighteen cases which occurred on the Alexandria area.

Serial number.	Date of attack.	Adjudged place of infection.	Residence.
11	February 6	8, Henderson-road	Belmont-street.
35	„ 22	30, Botany-road	The same.
36	„ 25	68, Botany-road	„
45	March 1	30, Botany-road	„
73	„ 19	90, Wyndham-street	„
*79	„ 22	14, John-street	„
90	„ 31	20, John-street	„
98	April 13	1, Bourke-street	„
107	„ 23	60, Phillip-street	„
109	„ 26	31, Raglan-street	„
115	May 4	Retreat-street, Botany-road	„
125	„ 11	Gray's Stables, Waterloo	151, Bullanaming-street.
133	„ 28	Grimley's Tannery, Botany-road	105, George-street, Redfern.
132	„ 29	69, Beaumont-street	The same
135	June 5	30, McEvoy-street	„
137	„ 2	77, Cooper-street	„
138	„ 5	17, Botany-street	„
139	„ 8	Louden's boot-factory, Elizabeth-street	54, Morehead-street.

* In Diagram IV this erroneously appears as No. 74.

Case 11. A.H., produce dealer, aged 30; place of residence, Belmont-street, Alexandria; of employment, 8 Henderson-road, Alexandria. Suddenly attacked 7th February, at 7 a.m., with vomiting, headache, and fever; right femoral bubo; both extremities much flea-bitten. Died 12th February.

106. A.H.'s cottage, in Belmont-street, was of weatherboard, in good repair, and clean; it had a stable for three horses in the backyard; the skeletons of three rats were found at the bottom of a dung-heap, but there was no evidence of infestation. The produce store stood close to the Botany-road, at a distance from the cottage of 56 chains. It was also 40 chains from R B.'s residence (Case 1), where that patient had lain ill for the four or five days from 4th to 8th November. It was a wood and iron building, which measured 19 feet by 47 feet; it had a brick front, and was floored with wood. There was a stable in one corner, and the place was dirty and ill-kept. For several weeks before his attack A.H. had not slept at home, but at this store on an extemporised bed of sacks. On taking up the floor the carcases of 39 rats were turned out, all too putrid for laboratory examination, and three healthy rats were killed.

107. Here this account of the beginnings of the epidemic may usefully be interrupted in order to point out that evidence of the dissemination of plague-rats in connection with no less than four produce stores has been adduced, namely, Exton's, Jones's, Goff's, and Huxley's; that bales of hay, &c., are notoriously liable to infestation by rats, which are easily transported in them; and that all four places were almost certainly connected, by the nature of the business carried on at them, with that line of wharfs at which produce is habitually handled, and at one of which a plague-rat was taken almost as soon as the rat search began, namely, on 18th November. We have seen, also, that plague in man occurred in connection with three out of these four stores; and, in the three widely separated neighbourhoods in which they stood, it first occurred in persons connected with the stores either as workmen, or as occupants of adjoining houses in free communication with the store by the space under the joists. Lastly, that the rats were affected before man; this was not demonstrable in Case 1, since the date of notification enabled search to be made only 10 days after attack; but, on the other hand the patient certainly did not infect the rats for reasons already mentioned (par. 77). The evidence on this head relating to Case 3, Paddington area, seems quite clear. Again, it is quite clear in relation to Case 11, for although the search was instituted within 48 hours of the time of attack, all the carcases found were not merely putrid, but too putrid for any useful examination in the laboratory. Later, other instances will be given in which there was no doubt at all that sickness and death of the rats had preceded the first case of illness among the persons inhabiting the premises where the carcases were found; such, for instance, are Group C, Cases 24 and 30, Her Majesty's Theatre and Hotel, and the Criterion Theatre and Hotel (pars. 198, 199, 210 to 216). If Case 1 be excepted, as I do not think it need be, then it can be said that disease in rats preceded disease in man in every case, the evident want of continuity between cases, and the observed establishment of independent centres, being borne in mind. For this discriminative infection of distant spots permits each such occurrence to be considered by itself, and to be regarded as complete in itself. Here, also, the reader will note the absence of infection in man in connection with Jones's store and the house in Cleveland-street; and while this point will be further examined below, the opportunity may be taken of repeating the remark already made (Report 1900, p. 36), that some special condition not usually present seems requisite to secure communication of the infection from rat to man.

108. The large block in which Huxley's store (Case 11) stood was taken in hand by the cleansing staff, but operations within it were not finished for about a month. No plague-rats were discovered in the course of them, nor any other instance of rat mortality. It was not until 21st March, more than a month later, that a plague-rat was collected in that block from the stable of a cabman 6 chains distant from Huxley's store, two days after his son had been attacked with plague (Case 73, the fifth on this area). Other plague-rats were taken later in the neighbourhood: one was identified among many carcases removed from 47, Henderson-road, which was a butcher's shop (see par. 111), and one at each of the houses 14 and 16, Botany-road, on April 8th and 9th, of which one was also used as a butcher's. No case of plague occurred at any of these houses.

109. The second case on this area happened sixteen days after the first in a school-boy (Case 35, attacked February 22nd, removed February 26th; right femoral bubo, recovered) at 30, Botany-road. This house stood north of, and 8 doors from, Henderson-road, and well within a hundred yards of Huxley's store. It was occupied by a pawnbroker, and was in a poor state of repair and maintenance. Floors were lifted, and a great deal of rat-rubbish removed from beneath them; there were holes in them and in skirting-boards, &c., as well as some burrows in the back-yard; no carcases were found and no live rats were seen. But the burrows were not dug out. This was an omission, of which the full significance was not perceived until after the experience gained at the Zoological Garden (see par. 176). It is here pointed out in connection with the occurrence of another case on these premises a week later, and after they had been cleansed and disinfected (Case 45, the fourth on this area, the above-mentioned patient's father, attacked 1st March).

110. The third case (Case 36) happened at 68, Botany-road, the patient, a child, having been attacked 25th February, on which day, also, he died (spleen and bubo yielded *b. pestis* in smears); this house having been on the same side of Botany-road as the last-mentioned, and only 12 doors south of it, though also separated from it by the intervening Henderson-road. It was therefore within a few yards of A.H.'s store. These premises were in very bad repair, and filthy; they were occupied by the patient's father, who was a dealer in bottles and old iron; 10 carcases of rats at about the same stage of putrefaction were removed, together with no less than 36 loads of rubbish and filth, but no plague-rat was identified.

111. The fourth and fifth cases (Cases 45 and 73) have been already mentioned; the sixth (Case 107) happened much later. It occurred in a letter carrier who was attacked on 23rd April. He lived at 60, Phillip-street, in a house which had a stable attached to it. The former was in good order and repair, and the inhabitants said they had no rats; nevertheless on lifting the floor 3 carcases were removed, all of which were too putrid for laboratory examination. This house stood about 15 chains from A.H.'s store. But it was only 6 chains from the shop of one Kerrigan, a butcher, on whose premises a sick rat, which was shown in the laboratory to be suffering from plague, had been taken on March 26th; on cleansing the shop immediately afterwards 80 putrid carcases were removed from the space under its rotten ground floors.

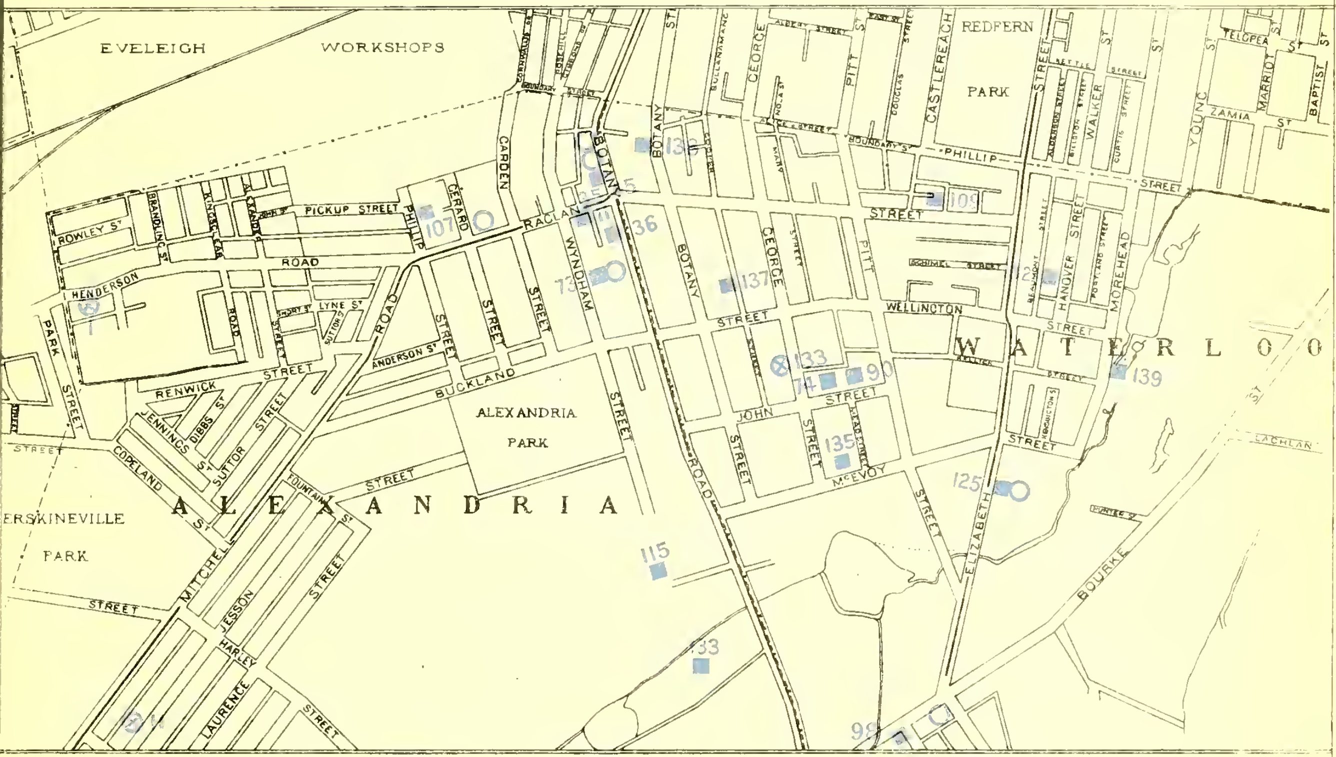
112. Two further cases (Case 115, 4th May, and Case 133, 28th May, being the eleventh and thirteenth on this area) occurred on this, the western side of Botany-road; they were separated from those above-mentioned, not so much in time as by distance. The premises on which they were judged to have been attacked stood 36 chains to the south of Henderson-road (A.H.'s store, &c.), and it is possible that the infection reached them from the eastern side of the road; for further cases had occurred in the immediate neighbourhood of Raglan-street on that side, and had gradually extended in a southerly direction until they had reached land opposite to that on which the houses of Cases 115 and 133 were placed. The series referred to comprised 11 cases (which occurred between Case 79, 22nd March, and Case 138, 8th June). The first two of them occurred in John-street, about 18 chains south-west from Raglan-street; the third, 18 chains further away towards the south; the remainder at various points between those two, and more or less removed from the east side of Botany-road. Case 79, a little girl, of John-street, was attacked (right inguinal bubo) on the third day after she had picked up and thrown out of her garden a dead rat; and on lifting the ground floors of her cottage, four carcases were found. Then Case 98, attacked 13th April at the southernmost extremity of the area, lived eight doors from the Zetland Hotel in Bourke-street, and from stables attached to this hotel a plague-rat was taken on 21st April. So also Case 125 occurred in a man who was attacked 11th May, at his place of employment, Gray's stables, within a short distance of the Zetland Hotel; and on 26th April a plague-rat had been caught at these stables. Sufficient evidence of a dissemination of plague-rats over this infected area was forthcoming, although household connection between diseased rats and the persons attacked was not established in the remainder of this short series.

Prepared for the Department of Public Health

ALEXANDRIA-WATERLOO AREA

Scale of Chains

16 12 8 4 0 16 32 48



NOTES

THIS DIAGRAM *shows by blue spots the places at which the 18 cases which constituted this sub-epidemic are adjudged to have received their infection. It shows, also, the places at which identified plague-rats were collected by blue open circles, but not the number of such rats. Blue circles which enclose a cross indicate houses at which persons adjudged to have been infected elsewhere resided, and at which they lay during the earlier days of illness. The numbers are the serial numbers of the cases referred to (for detail see Appendix A.)*

Seamen's Hospital Society
TROPICAL DISEASES
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TABLE XIII.—Showing the situation of premises on the Alexandria area at which plague-rats were taken, and the dates on which they were taken.

90, Wyndham-street	March 21.
47, Henderson's-road (Kerrigan's)	March 25.
16, Botany-road	April 8.
14, Botany-road	April 9.
Bourke-street (Zetland)	April 21.
Gray's stables, Elizabeth-street	April 26.

113. Lastly, on 8th June, which, as it afterwards turned out, was the day on which the last case of this epidemic was attacked, and on this part of the area, the latter was ordered to be specially searched by the rat-staff. During four or five weeks a large number of rats were gathered from 84 premises very evenly distributed over it (see diagram IV; the part referred to is bounded on two sides by Botany-road and Phillip-street, and on the third, in part, by Bourke-street). None were infected with plague.

SURVEY OF THE GENERAL RESULTS OF THE SEARCH FOR RATS OVER THE WHOLE OF THE AFFECTED AREA DOWN TO 17TH FEBRUARY.

114. In order to complete this description of the beginnings of the epidemic, it is necessary to add a reference to the general rat-search which was simultaneously carried on over a very considerable section of the city. I take, for the illustrative purpose in view, that part of it which lay between the dates, 16th November and 17th February (Case 23).

During the three months, 16th November to 17th February, rats were brought in by three agencies—the Departmental rat-staff, which delivered a few more than 12,000; the staff of the Local Authority for the city, which brought in 1,732; and those collected by the public and paid for by the Department at 3d. a head, which numbered nearly 18,000. The Departmental staff worked over a very wide area, including the city and adjacent suburbs, as well as some rather more remote which were occasionally visited, and those from which plague-cases had been removed; the city staff confined itself within its municipal boundaries, of course; while the origin of those presented by the public was seldom accurately known, though steps were taken to prevent them from being imported from distant places The Departmental staff visited and attempted to catch rats at a very large number of premises altogether, although even this total number bore but a small proportion to the total houses standing in the adjoining and other municipalities within which they worked; but the premises to which they paid *successful* visits numbered but 438 houses, &c., and 48 wharves; and their *successful* visits to this small number of premises were but 1,581. The only plague-rats which were identified were handed in by the Departmental staff; and as a rule the addresses at which rats brought in had been caught were known with certainty only when they had been taken by that staff. The net result of this hunt as regards plague rats is given below :—

TABLE XIV.—Showing the places at which identified plague-rats were collected between 16th November and 17th February, the dates on which they were collected, and the area on which these premises stood (see Diagram II).

Exton's produce store, Hay-street	November 15	South-central.
Howard Smith & Co.'s, Brisbane Wharf... ...	November 18	Darling Harbour.
Jones' produce store, 84, George-street	November 25	Chippendale.
Cleveland and Abercrombie Streets	November 26	Chippendale.
400, Kent-street, City	January 28	Darling Harbour.
Her Majesty's Hotel, 186, Pitt-street...... ...	January 29	Central.
445, Kent-street	February 6	Darling Harbour.
392, Kent-street	February 8	Darling Harbour.
169, George street West	February 10	Chippendale.
180, Pitt street	February 14	Central.
Buchanan's, New South Head Road	February 14	Paddington.
Matheson's produce store, New South Head Road	February 14	Paddington.
10, Maclean street, New South Head Road ...	February 14	Paddington.

But these plague-rats must not be regarded as the total yielded by the 12,000 rats taken by the Departmental staff; they should be compared with the number selected for delivery at the laboratory under conditions which have been already mentioned (see par. 81); and that was 914.

115. Thus the number of places at which plague-rats were found during the three months, 16th November to 17th February, was but 13, and the number of plague-rats identified was but 18. There were, however, a large number of rats which died of plague, their carcases having been found on premises which yielded at least one identified plague-rat; and were these reckoned the proportion of plague-rats to rats caught would be very largely increased. But this would add nothing to our knowledge; for we are aware that plague often rages on premises which are grossly infested, and consequently that the number of plague-rats found

must largely depend on the numbers which happen to lodge on the premises invaded. The more important point is to ascertain the number of separate premises and the number of different neighbourhoods in which plague-rats were found; this it is which indicates the extent to which the disease is disseminated as an epizoötic, and which, in my opinion should be compared with occurrences of it in man. That number was 13 premises only. It should surely have been larger; for some infected rats were found at several widely separated spots, and from experience at several premises (Exton's, Jones's, Huxley's) it is plain that the disease is sometimes easily communicated from rat to rat. The failure to discover more must have lain in part, then, in the mode of search; and good reason can be shown for ascribing it to this cause. The rat-staff worked at night, and with traps. They therefore caught rats which were running about and which were, for the most part at all events, in good health. Experience at Sydney has been that rats which have been attacked with plague have rarely been seen in the open; one instance has been mentioned in connection with the Paddington area, another will be mentioned in connection with a flour-mill on Darling Harbour area, another at the Zoological Garden (par. 174); but only four altogether were noted. Had they more frequently behaved, however, as they have been said to do in other countries, it is still improbable that they would have been taken in traps; for it is not likely that a sick rat would have either the energy or the inclinations which would lead it into them.

116. It seems sufficiently clear that the epizoötic did not spread very rapidly from building to building; doubtless it was often impeded by the mode of construction, which was that usual in European cities. Further, the disease seems to have been very easily communicable from rat to rat only under the special circumstance of association of large numbers in confined quarters. Nevertheless, there must have been many more infected rats than were found. Where were they, then? They must have been underground in their burrows; to them they must have retired on falling ill, and there for the most part they must have died. Some direct evidence that this does happen was yielded by the case of the Zoological Garden (par. 176); and, indeed, it was not until after that experience that the great importance to the epidemiological study of searching for and digging out burrows in connection with buildings was perceived.

117. But there was still another reason why plague-rats were not found in greater numbers; it arose from the search-conditions. In the first place, although it is impossible to estimate the number of houses on the irregular area which was the field of the operations under review with any approach to accuracy, it is quite certain that the premises at which rats were taken during the three months formed but a very small proportion of them. In the second place, it was indispensable that some number of rats should be fixed upon as sufficient evidence that each rat-catcher employed had done a satisfactory amount of work, and an effect of this practically unavoidable rule was, no doubt, to lead to payment of repeated visits to premises which were badly infested, while what was more desirable was examination of the largest possible number of different premises.

118. I conclude, then, first, that the identification of plague-rats as carried out furnished a trustworthy indication of the area of country over which the epizoötic extended, and that there is no good reason for supposing that it may have reached much beyond it; secondly, that it furnished little indication of its intensity.

119. There are two additional points upon which some remark should be made for the reader's assistance. The first is that there must, of course, have been some local *fons et origo* of the infection; and it is apparent that the latter spread from it, not by continuity at first, but *per saltum,* primary cases having been recognised in four separate districts, namely :—Cases 1 on the South-central, 10 and 12 on the adjacent Chippendale, 3 on the Paddington, and 11 on the Alexandria area. This view (of spread, at first *per saltum,* but afterwards by continuity from each new centre) depends on the cases mentioned having been primary cases in fact. Now notification of Case 1 was delayed until ten days after the date of attack; and two undiagnosed cases occurred on the Paddington area, where also Case 3 lay without medical attendance for nine or ten days after attack. These facts raise a legitimate doubt whether apparently primary cases were so in truth. Against

it may be pointed out (*a*) the absence of all ground for suspecting wilful concealment—a statement which applies as much to the Chinese, who here live as civilised and law-abiding citizens, as to whites; (*b*) that attention was drawn to one of the two undiagnosed cases by the medical man who had been in attendance upon it (to the extent, it will be remembered, of one visit paid an hour or two before death) as soon as he heard of the surrounding circumstances, while the diagnosis of the other (made after death without assistance of a detailed *post-mortem* examination) may, after all, possibly have been correct; (*c*) that all those who are best acquainted with the general circumstances do accept these early cases as having been the primary occurrences they appeared to be. Such investigations as the present would become impossible were this doubt (which, in a measure, might be raised in relation to the source of infection of every case) entertained without very good evidence for it; and evidence of the requisite kind may, in my opinion, be taken to be wanting.

120. The second point is, the detection of plague-rats (to speak generally) on premises where there was no plague in man, and the failure to find them (in a majority of cases) where there was plague in man. Enough has already been said, I think, to show that the negative aspect of these facts must be cautiously regarded. Coincidence of plague in man and in rats was demonstrated in several instances; and the failure to find plague-rats is, for substantial reasons which have been mentioned above, not even presumptive proof that plague-rats were not present. Besides this, however, it must be pointed out once more that plague-rats by themselves, and unaided, are incapable of causing epidemic bubonic plague. All that is required at this stage of the enquiry, therefore, is to show that the connection between rats and man, or the connection reasonably presumed in cases where the demonstration failed, existed as a mere matter of propinquity sufficiently often to warrant the inference that it is an essential condition of the occurrence of plague in man. This, I think, has been done even already; but much more evidence to the same purpose will be given later. However, the reader has the facts before him, and will judge of this for himself.

Darling Harbour Area.

121. The slow and obscure beginnings of the epidemic on a close-built city area, and its complete course within two other areas which comprised much more open space around the houses and much more unbuilt land in their neighbourhood, having been described, it is now necessary to give examples of its complete course, and of its relationship to epizoötic plague on areas which were altogether covered with houses, factories, markets, and wharfs. For this purpose I choose the Darling Harbour area and the Central area.

122. The number of cases which occurred upon the Darling Harbour area (see Diagram II) was 10, and they happened between 14th February and 20th April. It can be noted at once that, densely populated during the day as this area was, it did not yield cases of plague in proportionate number, although the infection was proved to have been present upon it from (I think it may be said) before the beginning of the epidemic until a date subsequent to attack of the last case by a few days, but subsequent to that of the last case on this area by nearly two months. This remark applies equally to the Central area, which yielded 32 cases between 14th February and 4th May. Yet the rise in the weekly number of notified cases which occurred, as has been shown, between the seventh and twelfth weeks (see Table II) was due entirely to addition of the 42 cases which arose on these two areas, without which the weekly number referred to would have varied between 1 and 8 only throughout the epidemic. This way of regarding the cases on the Darling Harbour and on the Central areas requires some explanation. It is justified by the fact that while the total 42 cases occurred on 29 premises, the patients resided on those premises only in 12 instances; and in the remaining 30 instances lived in districts which were for the most part remote, and, with three or four exceptions, free even from suspicion of infection with plague.

123. The 10 cases grouped on the Darling Harbour area can be further divided by locality into three sub-groups. These are shown in the Table below :—

Table XV.—Showing the serial number, date of attack, adjudged place of infection, and place of residence of the ten cases of plague which occurred on Darling Harbour area.

Case No.	Date of Attack.	Adjudged Place of Infection.	Residence.
		A.	
23	February 14 ...	232 Sussex-street (flour-mill)	Hugo-street, Redfern.
25	" 18 ...	39 Sussex-street	Lindfield.
28	" 22 ...	224–6 Sussex-street (produce)	Victoria-street, North Sydney.
42	" 27 ...	49–51 Sussex-street (produce-carter)	Young-street, Redfern.
56	March 10 ...	125 Sussex-street (produce)	Trafalgar-street, Annandale.
72	" 17 ...	Barque " Eulomene " ; potatoes supplied from 61–3 Sussex-street.	
		B.	
59	March 4 ...	Barker-lane	7 Barker-lane.
89	" 22 ...	Miller's Wharf, Liverpool and Bathurst streets	Victoria-street.
106	April 20 ...	Jones' Wharf (wood, coal), 2 Bathurst-street	2 Bathurst-street.
		C.	
104	April 20 ...	Grafton Bond	74 Princes-street.

124. First of all, it must be pointed out that Cases 23, 25, 28, 42, 56, 89, and 104 resided in neighbourhoods which never yielded indigenous cases. Their home premises also were either not infested with rats or, if in two or three instances visited by rats, were so in quite a moderate degree ; and no evidence of rat mortality on or in the neighbourhood of them was revealed by the inquiries which were made. Cases 59 and 106 were judged to have been infected where they lived. Case 72 was infected on board his ship, which had the communication with Sussex-street already described elsewhere (see par. 71).

125. What were the rat relations of the premises on which these cases are adjudged to have received their infection ? They are shown in the Table below. It should be noted that street numbers almost always run odd and even on opposite sides of the way :—

Table XVI.—Showing the situation of 21 premises on the Darling Harbour area at which plague-rats were taken, and the dates on which they were taken.

Howard Smith & Co.'s Brisbane Wharf	18 November.
400 Kent-street	28 January.
445 Kent-street	6 February.
392 Kent-street	8 February.
41 Sussex-street	18 and 19 February.
31 Sussex-street	21 February.
392 Kent-street	21 February.
North Coast Co.'s Wharf	25 February.
Napoleon-street (off 6, Sussex-street and Grafton Wharf)	25 February.
Huddart, Parker, & Co.'s Wharf (about 1 Sussex-street)	28 February.
Steam Mill street (off Barker-street)	19 March.
Barker-street	18 March.
Market Wharf (near 171 Sussex-street)	14 April.
Byrnes' Wharf (foot of Liverpool-street, 345 Sussex-street) ...	18 April.
Federal Wharf (bond, 1st floor, 209 Sussex-street)	19 April.
S.M.C. Wharf (off 279 Sussex-street)	23 April.
89 Liverpool-street	28 April.
311 Sussex-street	1 May.
318 Sussex-street	5 May.
Duncan-street (off 31 Bathurst-street)	9 May.
Market Wharf (near 171 Sussex-street)	13 June.

126. Thus the first plague-rat of all was found at a wharf which stood more or less at the centre of the line of wharves which bounds the Darling Harbour area to the east on 18th November ; the next 3 in Kent-street towards its south end,

one block east of Sussex-street, from 26th January to 8th February; and then follows a long list of 17, taken on premises which, with two exceptions, were either actually in Sussex-street or in side streets within a few doors of it, between 18th February and 13th June (see Diagram II). Now if Table XV be compared, it will be found that the takings of plague-rats on any premises coincided in no case with occurrence of plague on those premises; and, conversely, that plague did not occur, and that cases of plague could not, in any instance, be ascribed to infection received on premises where plague-rats were taken. It may be pointed out at once that this has been our usual experience. The total number of inhabited premises, or, more exactly, of premises which harboured people during the day, but were not used as dwellings by all of them, on which plague-rats were taken, was 40 during the whole epidemic, while plague occurred on 4 of them only. But this nett statement is not all that can be said on this point. Rats which had died from some unusual cause were often found on premises where plague in man occurred. Thus, Case 23 (both sets of cervical glands enlarged, smears and cultures positive; died), occurred in a youth employed at a steam flour-mill, who said that, on the day of attack, he had killed a sick rat at the mill by stamping on it, and had afterwards picked it up and thrown it away. The date of his infection, in all probability, was earlier than that referred to, which was the day of attack; but it appears that there were sick rats, or at least the one he killed, on the premises at which he worked. Case 25 has considerable interest from the circumstances surrounding it, although it is only one of a considerable number of similar cases. The important points were as follows:—

J.B.B., m., aged 19, a railway porter employed at Lindfield station, 7 miles from Milson's Point terminus, North Sydney. He was attacked, 18th February, in the evening; he had a right femoral bubo (morphological and cultural tests, positive); recovered. He lived in the neighbourhood of Lindfield station with his father, who had stables at his detached cottage and kept horses there; on 8th February the latter had received feed from 37, Sussex-street; the cottage was in good order and repair, clean; it was said that there were some rats about it and the stables, but that none sick or dead had been found. The patient did not work for his father, though no doubt he was exposed to any risk which may have attached to the stables; but on 18th February (railway books) he had helped a consignee to unload a considerable quantity of produce from railway trucks which had been forwarded from a store at Nos. 49–51, Sussex-street. In addition to this connection of his case with these premises, he was friendly with the son of the produce dealer who occupied them; and on 16th February had gone to Sydney and had spent the morning with him. It is not clear whether or not they entered Nos. 49–51, but No. 39 was at that time vacant. It was learned that young men used to meet there, and there the patient and his friend spent an hour or two. No plague-rats were found at No. 39 (which was not visited at any time), but they were found at No. 41, next door, on 18th and 19th February.

127. Under these circumstances, it is clearly possible that this patient may have been exposed to some risk of infection from the produce bought by his father at 37 Sussex-street, and received at Lindfield on 8th February, but this remains a possibility only; he could not have received the infection from the produce he unloaded, because he was attacked on the same day. But his visit to No. 39, Sussex-street (possibly, also, to Nos. 49-51), coincided with the most probable date of his infection; for, from the morning of 16th February (say, at 11 a.m.), to the evening of 18th February (say, at 8 p.m.) is fifty-seven hours, so that his illness began during the third day after his visit. No plague-rats were found at No. 39 (they were not searched for there) but some were taken at No. 41 (next door) on 18th and 19th February.

128. Case 28 occurred in a carter at a produce store, who sometimes slept on the ground-floor premises connected with stables in the back yard; and here, when the rotten flooring-boards were removed, a mass of rat-burrows was exposed, and 6 carcases, at about the same stage of putrefaction, were removed. Case 42 occurred in a carter at Nos. 49-51, Sussex-street, just mentioned above; but there was no history of dead rats in connection with Case 56, though the patient was certainly not infected at his residence in a distant suburb, and was carter to another Sussex-street produce dealer. The premises at which Case 59 lived, though in a neighbourhood consisting of poor house property (in very bad repair), factories, and wharfs, where plague-rats had been before and were afterwards found—one of them in the lane outside his house, and close to it—offered no sign of infestation. Stables at the wharf at which Case 89 was watchman were in bad repair and order, and infested with rats, but it was said that none dead had been seen there for three months before. Case 106 was stableman at premises attached to Jones' Wharf, and slept in a species of hutch extemporised for him. It was said that no rats had been seen, alive or dead, for a long time; however, on examination,

abundant signs of present infestation were seen, and three days after this patient's attack a plague-rat was taken at the Municipal Wharf at the foot of Bathurst-street; adjoining Jones' Wharf. These premises were also infested very badly with fleas.

129. The foregoing facts afford a further and fair example of the kind of relationship between diseased rats and plague in man which we have observed on closely-inhabited and (during the day) thickly-populated business areas. The long space of time, covering duration of the epidemic, during which plague-rats were forthcoming from the area described may be noted; the small proportion of the total buildings upon it (which, together with 41 wharf premises, were 1,234) from which plague-rats were collected; the small proportion of the total number of houses in which any rats were captured (namely, 88, to which 1,170 successful visits were paid by the ratcatchers); the want of coincidence between identified plague-rats and cases of plague in man on the same premises, but also the frequent association of rats recently dead from some epizoötic disease with plague in man may be pointed out. But, on the whole, I infer that the place-connection between epizoötic and epidemic plague is far from being in reality as obscure and doubtful as from the ascertained facts, which have been given above with scrupulous precautions against exaggeration, it might be judged to be by those who have never attempted to examine the rats of a large city. For the obscurity, in my opinion, arises solely from the difficulties which the investigation necessarily presents, namely, the physical circumstances of the area to be examined and the habits of the animals, together with ineptness of the labour which alone has been available for use as an instrument of search.

CENTRAL AREA.

130. We now turn to the Central area which, it seems most probable, was infected from the wharf line on Darling Harbour area, by way of streets running towards it in an easterly direction (King-street, for instance); the separation between the two areas being strongly marked by the entire freedom of Clarence-street, which runs north and south parallel with the wharf line, but some hundred yards easterly of it, both from plague-rats and from premises yielding dead rats. And it should be pointed out in relation to this latter statement (though the same is to be understood of all similar statements unless the contrary is mentioned) that the not finding of plague-rats or of dead rats in this street was not at all due to less thorough or briefer search in the houses which composed it.

131. The number of cases which occurred on the Central area was 32, and they can be divided by locality into 4 sub-groups; they are shown in the Table below.

TABLE XVII.—Showing the serial number, date of attack, adjudged place of infection, and place of residence of the 32 cases of plague associated with the Central area.

Serial Number.	Date of Attack.	Adjudged Place of Attack.	Residence.
A—			
18	Feb. 14 ...	Her Majesty's Theatre, 186 Pitt-street...	130 Reservoir-street.
19	Feb. 14 ...	Do do ...	22 Bullanaming-street, Redfern.
20	Feb. 15 ...	Do do ...	247 Church-street, Camperdown.
21	Feb. 12 ...	Do do ...	115 Nelson-street, Leichhardt.
33	Feb. 25 ...	Her Majesty's Hotel, do ...	Her Majesty's Hotel, 186–8 Pitt-st.
22	Feb. 16 ...	George Hotel, 188 Pitt street	George Hotel, 188 Pitt-street.
34	Feb. 24 ...	Siddaway's, 47 Market-street	59 High Holborn street.
43	Feb. 27 ...	Do do	Bondi.
B—			
26	Feb. 19 ...	Criterion Hotel, 258–262 Pitt street ...	George-street, Redfern.
27	Feb. 22 ...	Do do ...	Paragon Hotel, Circular Quay.
29	Feb. 21 ...	Do do ...	Criterion Hotel, 258–262 Pitt-street.
31	Feb. 23 ...	Do do ...	do do
32	Feb. 22 ...	Do do ...	do do
39	Feb. 24 ...	Do do ...	do do
40	Feb. 25 ...	Do do ...	do do

Serial Number.	Date of Attack.	Adjudged Place of Attack.	Residence.
C—			
41	Feb. 27 ...	482 George-street (chambers)	Orwell street, Pott's Point.
51	March 3 ...	(?) 251–7 Pitt-street	198 Oxford-street.
46	March 3 ...	(?) G.P.O., 137–57 Pitt-street	Hurstville.
49	Feb. 28 ...	237 Pitt street	Petersham.
55	March 12 ...	155 King street...	164 Woolloomooloo street.
57	March 10 ...	Imperial Arcade (off 170 Pitt-street) ...	165 Liverpool-street.
76	March 16 ...	105 King-street...	Bannister-lane, Ultimo.
80	March 25 ...	134 King-street...	134 King-street.
81	March 25 ...	Strand Arcade (off 195 Pitt-street) ...	Randwick.
84	March 26 ...	Royal Arcade, 267 Pitt-street	Strathfield.
116	May 4 ...	(?) 305 Pitt-street	37 Hutchinson-street, Surry Hills.
D—			
52	March 11 ...	Central Exchange Coffee Palace ...	Central Exchange Coffee Palace.
53	March 11 ...	Do	do
60	March 13 ...	(?) Do	115 Erskineville-road.
67	March 18 ...	114 York-street...	70 Walker-street, Redfern.
69	March 13 ...	(?) Central Exchange Coffee Palace ...	554 Crown-street.
75	March 20 ...	35 Market-street	8 Healey-street.

132. The 32 cases which occurred on the Central area were infected, as far as can be judged, on 17 premises only. A note of interrogation preceding the adjudged place of infection intimates that doubt attaches to it in that relation. At Her Majesty's Theatre and Hotel (which constituted one building structurally) 5 cases occurred, 2 at Siddaway's boot factory, 47 Market-street, 7 at the Criterion Hotel (and Theatre), 2 (probably) at chambers which ran through from 251–7 Pitt-street to 482 George-street; and in the Group D, which lay west of George-street, 4 (probably) in connection with the Central Exchange Coffee Palace. Their dates of infection extended only between 14th February and 26th March, if Case 116 (attacked 4th May) be omitted which may perhaps be done, because there was almost equally strong reason against regarding either the patient's place of residence or his place of employment as the place of his infection.

133. The ascertained state of the Central area as regards epizoötic plague is shown in the table below:—

Table XVIII.—Showing the situation of premises on the Central area at which plague-rats were taken, and the dates on which they were taken.

Her Majesty's Hotel and Theatre, 186–8 Pitt-street ...	Jan. 29, 30, 31, Feb. 1, 8, and 11.
180 Pitt-street	Feb. 14.
484A George-street...	Feb. 22.
Imperial Arcade, next 170 Pitt-street	Feb. 25.
74–78 King-street	Feb. 25.
King-street (F.F.I. Co.'s "new shop")	Feb. 26.
St. Andrew's School, 314 Pitt-street	March 4.
92 King-street	April 4, 5.
218 Pitt-street	April 5, 11.

134. On this area, then, plague-rats were identified in connection with Her Majesty's Theatre and Hotel (but see the special account of these and other premises which yielded multiple cases, pp. 52–56); dead rats in number at the Criterion Hotel; the same at 47 Market-street; a plague-rat at 484A George-street on 22nd February, which building is next to 482, where on 27th February Case 41 was attacked, and which also ran through to 251–7 Pitt-street, where Case 51 (attacked March 3) was at work as a house painter. Case 49 worked at a very badly infested tailor's shop, though no carcases were found at it. Case 55 worked at an hotel, where plenty of rats had been seen, and where (as the patient said) a sick rat had been caught the day before his attack, though no carcases were found. It was ascertained at the restaurant at which Case 57 worked, that 3 dead rats had been taken from under a staircase a few days before her attack, and it will be observed that No. 170 Pitt-street (see Table XVII) is but five doors from No. 180, where a plague-rat was taken on 14th February. Case 76 worked at a mercer's, which was badly infested, and whence 4 putrid carcases had been removed three days before her attack,

and 4 rat-nests from under the flooring-boards. Case 80 lived at a publichouse very badly infested, both by vermin and rats, whence 4 carcases and large quantities of rubbish accumulated by rats were removed. Case 84 occurred at a tailor's, where 9 carcases were removed from under the floor of the room in which the patient had worked, as well as very large quantities of accumulated rat-rubbish. So, also, as regards Sub-group D, very many carcases, live rats, rats' nests, and large accumulations of rat-rubbish were removed from the place at which Cases 52 and 53 lived and were attacked (compare, also, Cases 60 and 69, who more or less regularly frequented this eating-place). But, as regards the rest of this sub-group, no good evidence of disease among the rats which, nevertheless, infested the places of their employment, was obtained. Next, as regards the dwellings of those who did not reside at the adjudged place of their infection (namely, 22), seven lived in very remote suburbs, at distances of from 3 miles to 9 or 10 miles, only one of which ever yielded an indigenous case (but see Cases 61 and 127, Camperdown area, for the special circumstances), or harboured an imported case. The remainder lived at less distances of a mile or two, and not in suburbs; a majority of them dwelt in neighbourhoods which never fell under suspicion of infection. There were but two or three among them who could be considered to have run some danger from locality, but in no case were the dwellings of any of them found to have harboured dead rats, or to be infested with rats; nearly all of them having been absolutely free from all traces, I will not say of infestation, but even of visitation. Enough has been said, perhaps, of the Central area to show once more the kind of relationship which has been observed between plague-rats, or dead rats, and plague in man; and to show why, in the absence of evidence of spread by all those means which are elsewhere constantly invoked to explain the epidemicity of plague, we have concluded that, at Sydney, epizoötic plague is causally connected with epidemic plague, and not merely with occasional individual cases of this disease.

General Survey of the Remaining Areas.

135. The North-central area afforded but 6 cases of plague, of which 5 occurred at one house. Further reference to it may, therefore, be delayed until premises which yielded multiple cases come to be separately examined; but in the meantime it should be noted that in all respects of occupation and population, it was similar to the Central area just dealt with. Two of the 5 areas which alone remain to be noticed yielded 6 cases each on 5 premises in each, while the other 3 yielded only 2 cases each on 2 premises in each. These 5 areas are Woolloomooloo, South-west central, South-east central, Pyrmont, and Camperdown. Plague-rats were found in some neighbourhood or other at some date or other on each of them; but it is hardly worth while to continue the illustrations already given in detail of the kind of connection which existed between them and occurrences of plague in man, since the result would merely be to further exemplify what has already been described at length. Yet there is one which presented noteworthy points, of which, therefore, some details may be usefully given.

Camperdown Area.

136. Case 20, occurred in a scene-shifter, employed at Her Majesty's Theatre, who was adjudged to have been infected there, and who was attacked at home during the night of 15th February; he lived at 247, Church-street, Camperdown, and he lay there until 17th February, or for about 40 hours, when he was removed to hospital. He had a right inguinal bubo, morphological test positive; recovered; duration of illness, 23 days. Disinfection of his small one-storey cottage was begun immediately after his removal, and was quickly completed. It was of wood and brick, dilapidated, dirty, damp, rotten, and infested with insects, but free from all traces of rats.

137. A month later—that is to say, on 13th March—Case 61 was attacked at 77, George-street, Camperdown, 7 or 8 chains easterly from Case 20 (see Diagram II). This patient was an old woman, who had not been away from home for a long time past. She had a right axillary bubo, was removed on the third day of illness, and died on the fifth day. Her cottage was of brick and weatherboard, and in a condition

which rendered it unfit for habitation, so that soon afterwards it was pulled down with consent of the owner. It was very badly infested with rats; the patient's husband said he had removed 3 carcases from his bedroom on 6th March, but also that he had previously laid poison; on raising the floors abundant traces of present infestation were found, and 3 more putrid carcases were removed from under the bedroom floor. On one side of this cottage was a house which had a stable attached to it.

138. In consequence of occurrence of Case 61 a block which was bounded by George-street, Church-street, Burton-street, and Missenden-road was taken in hand by the cleansing staff on 25th March (finished 7th April), which included a produce store at the corner of Missenden-road and George-street. Prior to this the neighbourhood had begun to be searched by the rat staff, but nothing of importance had resulted, except that rats were found in considerable numbers at the produce store just referred to—17 having been caught there by it on the night of 25th March.

139. After a rather long interval, namely, on 21st April, one plague-rat, and on 23rd April, 3 plague-rats, were brought in from the store (search of these particular premises having been intermitted of course, and probably resumed merely because it was a good place at which to catch rats), whereupon the place was closed for cleansing and reconstruction. It included no living apartments; its proprietor occupied a house erected on a low bank at the back of it, entirely detached, and reached by a flight of uncovered wooden steps. Here his wife (Case 127) was attacked with plague on 13th May; she exhibited a right axillary bubo, and recovered. No further carcases were found at the dwelling, which was reported to have been in good order and repair; the store had continued closed from about 25th April, cementing of rubble foundation-walls and concreting of the floor not having been completed until long after attack of Case 127.

140. This instance presents several points which deserve attention. In the first place the neighbourhood was remote from other infected spots, and doubtless received its infection *per saltum*; in that case there is a reasonable presumption, raised by experience on other remote areas already recounted, that it was transported there with supplies delivered at the produce store. Now the owner of the stable next to the house at which Case 61 lay procured his feed from this store. But the dates do not nearly agree. Case 61 was attacked 38 days before a plague rat was found at the produce store, and as far as this point furnishes a hint it suggests that the infection was really travelling the other way—that is to say, easterly from Case 61 towards the produce store, and not westerly from the store to Case 61.

141. Attention is thus drawn to Case 20, which lay still further west of the produce store than Case 61, and to the statement which has been made that the infection is commonly introduced to a clean neighbourhood by man and communicated from him to the rats.* Evidently, from the pathology of plague, this might happen, although reason has never appeared in our experience for suspecting it; and the present instance seems to me not to be one which suggests that sequence of events. For, on those same pathological grounds, a case of bubonic plague of an unusually mild description (the patient was discharged from hospital on the twenty-third day of illness) cannot be supposed capable of diffusing infectious matters during the first 40 hours after the onset, within which term this patient was removed to hospital; his cottage, it will be remembered, having been disinfected immediately afterwards, and finished within less than 72 hours of his first symptoms There is thus every reason for regarding Case 20 as independent altogether of the two subsequent cases and of the plague-rats afterwards found, and as having been merely one of those imported cases of which so many were met with during the former (as well as during this) epidemic, and from which no communication of the disease either from man to rats or from man to man ever took place.

142. How did Case 61 come to be infected from the produce store since plague-rats were not found at it until 38 days later? There is, indeed, no more than a suggestion that the infection was received thence; and the possibility must

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* See for instance Memorandum on the Influence of Rats in the dissemination of Plague, by W. J. Simpson, M.D., printed for use of the Colonial Office, May, 1900. "Man as a rule is the chief importer of plague into a locality, while the rat at the commencement is the chief disseminator."

be noted that it was carried into the neighbourhood in some quite other and undiscovered way, and that it may have spread gradually from some point much further to the west, perhaps, than even Case 20, through the premises at which Case 61 dwelt, and so towards the produce store. Such conjectures, however, are merely disabling unless they arise in some ascertained probability; and no such probability ever appeared, notwithstanding such a watchful examination and consideration of the circumstances as at the time justified the setting aside of the origin of the infection which the certainly indigenous Case 61 had received as an unsolved problem.

143. We have then to review the data, and on doing so it appears that as a matter of fact there is no evidence that the produce store was free from rat-plague at any particular date prior to 21st April. Even the healthiness of the 17 rats taken there on 28th March must remain doubtful, for at that date only selected rats, and those chosen by the rat-catchers themselves in accordance with rough general rules which have already been mentioned, were delivered at the laboratory; while, as noted above, the premises were not kept under anything approaching continuous observation after failure of the efforts to discover plague-rats in the neighbourhood, which were made immediately on notification of Case 61. Hence this case illustrates the practical difficulties met with in attempting to demonstrate in the field the nature, in particular instances, of the connection between epizoötic and epidemic plague, as much as anything else; and therefore it may be left, after it has been pointed out that Case 127 did not occur in the detached, elevated, cottage behind the produce store, until the latter had begun to be thoroughly turned out in the course of repairing it so as to render access of rats to it less likely, and the burrowing of rats under its floors and about its foundations almost impossible.

DESCRIPTION OF A SINGLE INDIGENOUS CASE AT NEWTOWN.

144. There is also one case, solitary and detached by neighbourhood from all others, which occurred at Newtown; it deserves description, because the discovery of plague-rats once more clearly preceded the infection of man by several days.

145. On 23rd April the Sanitary Inspector to the Local Authority for Newtown delivered at the laboratory two rats which had been picked up in a lane at rear of premises occupied by the Davis Butchering Co., 257, King-street; they presented gross signs like plague, but were too putrid for demonstration of the nature of their disease. On each of the days, 25th, 26th, and 30th April and 1st May, other rats caught or found dead on the premises named were brought in by the Departmental staff to the number of 62, ten of which were ascertained to be infected with plague. No plague-rats were collected from adjoining or adjacent premises; and as soon as the butcher's shop had been closed and handed over to the cleansing-staff, together with the whole block in which it stood, delivery of rats at the laboratory ceased, in accordance with the custom which arose merely in the exigencies of work, and which was designed to relieve the laboratory staff as soon as the fact that the rats on any particular premises or in any cleansing-block of buildings were infected with plague had been firmly established. The shop was of moderate size, in a city street; it was in very bad structural state, and had a small yard entirely built over. The latter contained stables where several horses were kept, annexes used for purposes of the extensive business, and accommodation for the slaughtering of fowls which were temporarily housed there to an average number of about 2,000.

146. There were also in the same block several old premises which had been allowed to stand from times when this suburb was rural until leases should fall in; they were in an indescribable state of disrepair, though presenting to the high road on which they stood shop-fronts which, to the casual observer, were not quite disreputable. All of these were so badly infested with rats and clogged with rats'-dung in every part not habitually walked over that it seemed doubtful whether man or the rats might more justly be deemed to have possession. These shanties were interspersed among many fine buildings which from time to time had been erected on allotments of which the leases had fallen in more or fewer years before; and

their continued existence was a disgrace to the Local Authority, who appeared to be ignorant of the ample powers which they possessed under the Public Health Act, 1896, to cause them to be closed and demolished.

Case 108. A. P., m., 54; suddenly attacked 27th April; left femoral bubo; recovered. Was a cabinetmaker employed at 363 Kent-street, with eight others; the shop was in excellent state, and no suspicion ever attached to it. Resided at 245 King-street, Newtown, five doors from the Davis Butchering Company, and in the block which was cleansed in connection therewith. Here his family kept a stationer's shop; the building was in bad repair, average cleanliness, and on being taken in hand by the disinfecting staff was found to show abundant signs of being badly infested with rats; but only one carcase was removed from beneath one of the floors.

147. The carcases brought in on 25th April had been soon ascertained with sufficient completeness, under the circumstances, to have died of plague; but time was afterwards lost in attempting to get the Local Authority to do its duty, under supervision, without success; and partly in consequence Case 108 was attacked before cleansing of his premises had begun.

148. Here we see an instance of place infection *per saltum*, and a further instance of precedence of rat-infection over the infection of man. Here, also, is another illustration of our not uncommon experience—namely, that persons exposed on premises where rats are most numerous and are suffering most heavily from plague are, nevertheless, not necessarily the first to suffer, nor even sure to be attacked at all; while persons living in the neighbourhood on premises which show no important sign of presence of epizoötic plague may and do suffer. In short, as we know that plague-rats are not in and by themselves infective for man, so we are compelled by this and many similar examples to assume that the chain of circumstances necessary to bring about communication of this septicæmia of the rat to man is lengthy, and rarely complete in all its links; for though the neighbourhood of plague-rats seems necessary to bring about infection, contact with them is clearly not necessary and, if brought about, does not ensure, nor much increase the probability of, its being contracted.

149. With the two preceding instances, which present features differentiating them from others so far mentioned and worthy of careful consideration, I conclude this exposition of the beginnings of the epidemic, to which accounts of its complete course on certain areas have been added. It does not comprise a reference to every case that occurred, nor a description of the events recorded of every area; but it has been carried almost as far as is necessary to pourtray the usual course of events, and (it is hoped) to place the reader in possession of the general grounds on which we have formed our opinion that epizoötic plague among rats is here a precedent and indispensable condition of epidemic plague. It remains, however, to examine the distribution of cases among houses in relation to alleged spread of the infection of plague from the sick to the well by direct, and by indirect, channels. Before doing so, however, there still remain two occurrences which must not be omitted from description. One concerns plague in man, marsupial and some other animals, and in rats at the Zoological Garden at Sydney; the other a solitary indigenous case at the city of Newcastle. Both of them throw light on the practical management of plague-epidemics; the former also contains some novel observations of interest.

Plague at the Zoological Garden.

150. On 11th April, the Superintendent of the Zoological Garden submitted the intestines and liver of a wallaby for examination in the analytical laboratory. He said that during the preceding six days 7 kangaroos and wallabies, which had been in apparent good health, had suddenly fallen down, become convulsed, and had died after about two hours' illness, whence he suspected poisoning. In the analytical laboratory signs of disease were noticed in the liver, and the specimen was referred to the micro-biological laboratory. By the 18th April it had been definitely ascertained that this animal had died of plague.

151. On that date, therefore, the Secretary to the Trustees was directed to close the Garden to the public, and he was informed that a thorough cleansing and disinfection of the grounds and cages must be commenced at once. The work was carried out under immediate direction of Sanitary Inspectors of this Department, the Trustees having found labour and materials.

152. Before proceeding to describe the course of events subsequent to 18th April, it will be well to mention the organisation which existed, as well as the state of the Garden, at the time it began to be cleansed. The Garden was first established in 1880. It was placed under management of a Board of Trustees. Its income was made up of donations, subscriptions, admission moneys, and a small annual subsidy from public funds, and had never been quite adequate to the reasonable needs of the institution. These facts are mentioned because, although the collection of specimens, the laying out of the Garden, the arrangement of cages and enclosures, and the general appearance of the institution were highly creditable to the Trustees, many and serious defects came to light, of which some could not have been effectually prevented or removed, except at a cost far beyond any resources which ever had been at their command. The Board has now drawn attention to this matter, and has submitted several recommendations upon it to the Government.

153. The Garden occupied a triangular piece of land which measured about twelve acres and a half, and which was enclosed by a galvanized iron fence in bad repair; it occupied the angle formed by the junction of Cleveland-street with Randwick-road, and was bounded towards the north by Moore Park, towards the east by a great extent of park lands, while on its third side there were no houses towards the west for a hundred yards (see Diagram II). The subsoil was blown sand, of great depth. Water was supplied from the public mains; but in the middle of the well-planted enclosure was a small lake, which was filled by surface-waters. The lake was furnished with an overflow pipe, which entered a sluice-box on its bank; the drain from the sluice-box was of 6-inch e.w.g. piping, the mouth of which was defended by a wooden sluice-valve, found on examination to effectually stop it, and said not to have been raised since heavy rain had fallen several months before; it discharged into a covered storm-water drain 30 or 40 chains distant. At beginning of April the pond was already almost dry.

154. About the date at which the unusual mortality among the caged animals began, the collection consisted of between 400 and 500 specimens. The staff comprised 6 keepers, 3 gardeners, a butcher, a gate-keeper, and a carpenter, under a working superintendent (Mr. Holmes). The cages were for the most part arranged around the three boundaries, but not everywhere in single lines; there were, in addition, many aviaries and houses scattered about the inner part of the grounds. There were also a refreshment room, a pavilion for visitors, an office building, and a residence for the superintendent, who was the only member of the staff who slept on the premises. Near one corner of the triangular enclosure was a slaughter-house and boiling-vats; here, also, was a dung-heap, where it had been the custom to accumulate all stable-bedding and refuse for twelve months at a time, with a view to using it at the proper season to enrich the sandy soil.

155. The premises were not connected with the sewers. The public urinals discharged into the sand; other conveniences were furnished with pails, which were emptied by the staff, the contents being utilised about the grounds. Several of the cages occupied by the larger animals drained by e.w.g. piping to the little central lake; but others of them had wooden floors, through which stalings and the like found a way to the under-space, which in some cases was enclosed by brick walls, and was dark and filthy. The enormous dung-heap, then representing about eleven months accumulations, was offensive; and at this part of the grounds were several cottages, or small wooden buildings, which at some time had been in use, but which had become ruinous, filthy, and overgrown with weeds. Near by was the slaughter-yard, which was unsuitably found; although superficially not very unclean, it was in reality extremely foul, and its construction was such that it hardly could have been kept strictly clean. A very large quantity of lumber and refuse was removed from various parts of the enclosure, and burned; and some places were so offensive that the men could work for only a few minutes at a time. In short, it seemed remarkable, under these conditions, that none of those outbreaks of septicæmic diseases, to which animals in confinement are especially subject, had previously been reported.

156. The cleansing operations occupied several weeks, and during the earlier part of them the mortality among the caged animals continued unusually high. Whereas the monthly number of deaths was said to have been generally from 5 to 8,

between 5th April and 10th June no less than 52 occurred. The bodies of 45 of these animals were examined in the laboratory, with the results described by the Micro-Biologist in the following report. Briefly, in 11 carcases, which comprised 7 marsupials, 1 Indian antelope, and 3 guinea-pigs, plague was demonstrated; in 8 carcases, which included 6 marsupials, although the *post-mortem* signs suggested death from plague, bacteriological tests did not confirm the suspicion; while in the remaining 26 no signs of plague were discovered, 4 of the carcases having been received in too putrid a state, while 10 others furnished clear evidence of some other cause of death.

Bacteriological Report on an outbreak of Plague amongst Animals at the Zoological Garden. By Frank Tidswell, M.B., M.Ch., D.P.H., Micro-Biologist to the Board of Health.

157. It has happened that from time to time the viscera of various animals dying under suspicious circumstances at the Zoological Gardens have been submitted to this Department for chemical analysis. In accordance with this custom the stomach and liver of a Wallaby (Macropus sp.) was brought to the chemical laboratory on April 12th, 1902, but was referred to this laboratory because the liver showed signs of being diseased. On examination this organ appeared to be swollen and softer than natural. It was deeply congested, and showed numerous greyish white necrotic looking areas of various sizes, but mostly about 4 or 5 millimetres in diameter. Smear preparations revealed the presence of numerous bacilli, most abundant in the necrotic areas, but present also in the tissue between them, the appearance of which suggested *bacillus pestis bubonicaæ*. The further examination of these micro-organisms gave the following results:—

(*I.*) *Morphological characters.*

158. Bacilli in the original preparations polymorphic, but for the most part ovoid or shortly cylindrical with rounded ends; measuring 1·6–2·4μ long, by ·5 to ·8μ broad. Specimens from cultures were more regularly in form of bacilli and shorter than in the original preparations. Specimens from dry agar cultures showed numerous swollen, rounded or oval, often vacuolated elements (involution forms). In the original preparations and those from solid culture media the individual bacilli were isolated, but preparations from broth showed short chains. In hanging drop preparations most of the elements were quiescent; here and there some were found wriggling, but no change of place occurred. No spores were observed, neither in the original preparations nor in any from cultures or tissues subsequently examined. The bacilli stained readily with ordinary aqueous solutions of fuchsine or methylene blue, showing marked bipolar colouration, but were discolourised by Gram's method.

(*II.*) *Cultural characters.*

159. *On nutrient agar* at 36°C. inoculated with the original material, the growth was visible in about twenty-four hours in the form of minute bright dots. During the succeeding few days these became more or less fused into a confluent growth; semi-transparent at the edges, cloudy in the middle. Sub-cultures appeared in about twenty-four hours in the form of faintly cloudy streaks 2 or 3 millimetres wide, sticky. The growths were composed of bacilli possessing the morphological characters described above. *On dry agar* the growth was very scanty and showed numerous involution forms, as already mentioned. *On nutrient gelatine plates* at room temperature, growth appeared in forty-eight hours in the form of colourless dots. Under the microscope the colonies were granular, generally rounded in outline, but showing blunt angulation at different points of the circumference. *In gelatine tubes* the surface streak was whiter than upon agar, and the granular growth appeared for a short distance below the surface in stab cultures. The gelatine was not liquefied. *On Loeffler serum* at 36°C. sub-cultures appeared in twenty-four hours, and subsequently developed into a streak 2 or 3 millimetres broad, thicker than corresponding agar growths. *In bouillon* at 36°C. there was a formation of spicules of growth attached to the sides of the tubes, and a scanty deposit at the bottom; the broth remained clear. Special sub-cultures in flat flasks gave abundant stalactitic growths.

(*III.*) *Pathogenic characters.*

160. Guinea-pig A, inoculated in leg from a twenty-four hours old agar culture, became sick in twenty-four hours, developed a bubo on following day; was comatose on third day, and found dead on morning of fourth day after inoculation. The region of inoculation was swollen, and showed haemorrhagic oedema; adjacent inguino-femoral lymphatic glands swollen, deep red in colour, and surrounded by sanious effusion. Numerous small hæmorrhages under the skin and serous membranes, and in heart, lungs, liver, kidneys, spleen and intestines. Viscera showed general congestion. Liver enlarged, and showed greyish necrotic spots. Spleen enlarged and richly mottled with small grey necrotic spots. Suprarenal bodies deep red in colour. The bacilli above described were abundantly present in the blood and viscera generally, and pure cultures were obtained upon various media inoculated with material from the inguino-femoral glands, liver, and spleen.

161. Guinea-pig B, inoculated from same culture as A, became sick in twenty-four hours; bubo developed in same day; got gradually worse during next two days; was comatose on evening of fourth day, and was found dead on the morning of the fifth day after inoculation. *Post-mortem* appearances of practically same character as guineapig A, but spleen larger and even more richly mottled with greyish areas. The bacilli were abundantly present in preparations from the bubo, liver, and spleen, and were obtained in pure cultures from same organs.

162. Guinea-pig C, inoculated in the leg with scrapings from the liver of guinea-pig A, became sick and developed bubo in twenty-four hours; got gradually worse and died during the fourth day after inoculation. The *post-mortem* appearances were similar to those in guinea-pig A. The bacilli were abundantly present in preparations made from the spleen, liver, bubo, and blood, and were obtained in cultures.

163. A rat—which had been kept in a cage for about a month during which time it remained in apparently perfect health—was inoculated in the leg from an agar culture obtained from original material. The animal was slightly sick in twenty-four hours, grew gradually worse, and died on the fourth day after inoculation. The *post-mortem* examination revealed extensive hæmorrhagic œdema spreading up leg and along abdomen as far as chest. Inguino-femoral glands swollen, and deep red in colour. numerous small hæmorrhages under serous membranes, and in heart, lungs, liver, spleen, kidneys, and intestines; pneumonic consolidation of lungs; liver enlarged to nearly twice normal size, spleen swollen to three or four times normal size; suprarenal bodies swollen and deep red in colour; the peritoneum contained an excess of serous fluid. Bacilli abundantly present in preparations from bubo, peritoneal fluid, liver, and spleen, and obtained in cultures from same organs.

164. The issue of these various observations thus afforded abundant confirmation of the original impression that the micro-organisms in question were *bacillus pestis bubonicæ.*

165. From the date of receipt of the specimen just mentioned (12th April, 1902) up to 10th June, 1902, examination was made of forty-five animals dying at the Gardens. With one exception these animals were subjected to regular *post-mortem* examination, and materials then taken were used to perform a series of tests similar to those described in connection with the first specimen. The observations are briefly stated in the subjoined tabular statement. The heavy pressure of laboratory work prevented the performance of any experiments other than those required to confirm or negative plague, but obvious indications of other diseases are duly noted in the table. (Page 43.)

166. Perusal of the list there given will show that with respect to the results of the examination the animals can be divided into three classes,—

(*a*) Those positively ascertained to be infected with plague; comprising eleven animals, viz., four wallabies, one wallaroo, one pademelou, one tree kangaroo, one Indian antelope, and three guineapigs.

(*b*) Those in which the *post-mortem* signs were suggestive of plague, but the subsequent bacteriological tests were negative; comprising eight animals, viz, New Guinea kangaroo, pademelou, native cat, rabbit-bandicoot, Indian sheep, macaque monkey, and two opossums.

(*c*) Those in which both the post-mortem examination and the confirmatory tests were negative; comprising the remaining twenty-six animals. Of these four, fallow deer, axis deer, opossum, and macaque monkey, were too putrid for satisfactory examination; ten, polar bear, tiger cat, opossum, guinea pigs (2), New Guinea monitor, Syrian goat, Australian eagle, Australian owl, and magpie, showed evidence that death might have been due to other causes, whilst the remaining twelve, macaque monkey, kangaroo rat, native cat, coypu rat, guinea pig, and seven birds, adjutant, flamingo, crane, ducks (3), and marten, gave entirely negative results.

167. It will be seen, therefore, that plague was actually found to have affected seven marsupials, one ungulate and three rodents; that there was unconfirmed suspicion of it in six marsupials, one ungulate and one monkey. For the rest it need only be noted that none of the birds examined showed any signs of plague.

168. It may be added that between dates 16th April and 10th June, 1902, there were examined seventy-six rats taken at the Zoological Gardens, and of these no less than nineteen were found to be infected with plague. As stated elsewhere there was also a case in a human being in connection with this outbreak.

169. The association of plague in the lower animals with epidemics in man forms a noteworthy feature of the older writings upon the disease. Modern observation has shown that many species are susceptible to artificial infection, and that some few, notably monkeys and rodents (rats, mice, bandicoots, squirrels and marmots), acquire plague by natural means. The guinea-pig and rabbit are readily infected artificially, but I believe there is no record of a natural epizoötic amongst them. The carnivora are said to be much less susceptible; cats occasionally take the disease, but dogs appear not to do so. The Ungulata are variably, and in general only slightly, susceptible to artificial infection, and it is doubtful whether the disease is capable of becoming epizoötic amongst them. There is no reference in available records to other species of mammals. Amongst birds, pigeons and domestic poultry are said to have suffered, but the evidence with respect to their susceptibility is contradictory. The data concerning reptiles is equally uncertain; some observers assert, others deny, the susceptibility of snakes, lizards and frogs. There is no available evidence with respect to the fishes. The only records concerning the invertebrata with which I am acquainted report the death of flies, and the presence of the bacilli in, or in the excreta of, ants, fleas, and bugs. As far as I have been able to ascertain the series of cases now reported upon contain, the first recorded instances of the infection in marsupials. The special selection of these animals is interesting in view of the belief in their zoological kinship to rodents.

TABLE XIX.

No.	Date.	Animal.	*Post-mortem* Appearances.	Bacteriological Examination.				Diagnosis.	Remarks.
				Specimen	Smear Preparations.	Culture	Result of inoculation.		
1	1902. 12 April ...	Wallaby, *Macropus sp.*	*Vide* supra	*Vide* supra.				Plague.	
2	17 ,, ..	Fallow Deer, *Cervus dama*, Linn.	Portion of liver; no definite pathological lesions	Liver	N ...	Overgrown	...	Negative	Specimen putrid.
3	24 ,, ...	Wallaroo, *Macropus robustus*, Gould.	Bubo in left inguinal region, suppurating; no hæmorrhages; liver shows numerous small necrotic areas; spleen greatly enlarged and softened	Spleen Liver Left inguinal glands.	N ... P ... P ...	... ...	... ...	Plague.	
4	24 ,, ...	Pademelon, *Macropus thetidis*, Lesson.	Bubo of left inguinal region; hæmorrhages in inguinal and axillary regions on both sides, in liver, stomach, intestines, kidneys, suprarenal bodies, and lungs; excess of fluid (sanguineous) in peritoneal and pericardial sacs.	Left inguinal glands. Liver Spleen	P ... P ... P ...	... P ... P ...	... ...	Plague.	
5	27 ,, ...	Tree Kangaroo ...	Bubo of left inguinal region; hæmorrhages in inguino-femoral, axillary, and mesenteric lymph glands, heart, lungs, liver, kidneys, suprarenal bodies, stomach, intestines, and into peritoneal membrane; bladder contains blood-stained urine; excess of sanguineous fluid in pericardial and peritoneal sacs	Left inguinal glands. Liver Spleen	P ... P ... N ...	P ... P ... P ...	... ...	Plague.	
6	28 ,, ..	Native Cat, *Dasyurus viverinus*, Shaw.	No signs of disease	None	...	...	...	....	Killed in mistake for rat.
7	29 ,, ...	Kagu Crane, *Rhinochetus jubatus*.	No signs of disease	Liver Spleen	N ... N ..	N ... N ...	... ...	Negative.	
8	29 ,, ...	Kangaroo Rat, *Æpyprymnus rufescens*, Gray.	No signs of disease	Liver Spleen Left inguinal glands.	N ... N ... N ...	N ... N ... N ...	... ...	Negative.	
9	29 ,, ...	Opossum	No bubo; hæmorrhages in skin, liver, kidneys, suprarenal bodies, stomach, intestines, mesenteric glands, heart, and lungs: excess of clear fluid in peritoneal sac; liver and spleen slightly enlarged	Liver Spleen	N ... N ...	N ... N ...	... ...	Negative.	
10	29 ,, ...	Pademelon, *Macropus thetidis*, Lesson.	No bubo; hæmorrhages in skin, muscle, liver, spleen, kidney, suprarenal bodies, stomach, intestines, mesenteric glands, heart: bleeding from nasal mucous membrane; excess of clear fluid in peritoneal sac; liver and spleen slightly enlarged...	Liver Spleen Nasal m.m.	N ... N ... N ...	N ... N ... N ...	... ...	Negative.	
11	29 ,, ...	New Guinea Kangaroo.	Bubo of right inguinal region; hæmorrhages in skin, peritoneal serosa, liver, spleen, kidneys, suprarenal bodies, stomach, intestines, mesenteric glands, heart, and lungs; bladder contained blood-stained urine; liver, spleen, and mesenteric glands enlarged; lungs show patchy pneumonia; nasal mucous membrane deeply congested; subcutaneous œdema in ventral parts	Liver Spleen Right inguinal glands Mesenteric glands ... Nasal m.	N ... N ... N ... N ... N ...	N ... N ... N ... N ... N ...	... ...	Negative.	
12	29 ,, ...	Adjutant Bird, *Leptoptilus argala*, Linn.	No bubo; numerous small hæmorrhages in bowel, none elsewhere; no definite changes in organs	Spleen Liver Blood	N ... N ... N ..	N ... N ... N ...	... ...	Negative.	
13	29 ,, ...	Macaque Monkey, *Macacus sp.*	No bubo; no hæmorrhages, and no definite pathological lesions	Liver Spleen	N ... N ...	N ... N ...	... ...	Negative.	
14	29 ,, ...	Polar Bear, *Ursus maritimus*, Linn.	No bubo; inguinal and axillary glands deep red on section; viscera generally congested; lungs pneumonic; animal emaciated and dirty; had been ailing several months; illness said to have started from broken tooth	Liver Spleen Right inguinal glands Left ,, ,,	N ... N ... N ... N ...	N ... N ... N ... N ...	... ...	Negative.	Viscera gave streptococcus and pyogenes and staphylococcus phyogenes aureus.
15	1 May ...	Owl (Australian Species), *Strix delicatula*, Gould.	Emaciated; no hæmorrhages; general congestion of viscera; had had diarrhœa	Liver Spleen Heart-blood	N ... N ... N ...	N ... N ... N ...	... ...	Negative.	Bacillus isolated; resembled chicken cholera, but not pathogenic to fowls.

No.	Date.	Animal.	*Post-mortem* Appearances.	Bacteriological Examination.				Diagnosis.	Remarks.
				Specimen.	Smear Preparations.	Culture.	Result of Inoculation.		
16	1902. 1 May	Indian Sheep, *Ovis sp.*	Bubo of right inguinal glands; hæmorrhages in subcutaneous tissue, under peritoneal serosa, in heart and lungs; viscera generally congested; lungs pneumonic; decomposition commenced at time of examination	Liver	N	N	...	Negative	Some bacilli resembling *B. Pestis* in smears, but not confirmed by other tests.
				Spleen	N	N	...		
				Right inguinal glands	N	N	...		
17	4 ,,	White Duck	No definite *post-mortem* signs	Liver	N	N	..	Negative	Overgrown.
				Spleen	N	N	...		
				Heart-blood	N	N	...		
18	5 ,,	Guinea-pig, *Cavia Cutleri*, Bennet	Lungs pneumonic; no other lesions	Liver	N	Mixed	...	Negative	Pneumonia.
19	5 ,,	Mandarin Duck, *Aix galericulata*, Linn.	No definite pathological lesions	Liver	N	N	...	Negative.	
				Spleen	N	N	...		
				Heart-blood	N	N	...		
20	5 ,,	Wallaby, *Macropus sp.*	Bubo of right inguinal glands; hæmorrhages in liver, spleen, kidneys, suprarenal bodies, skin, lungs, heart, bladder contained blood-stained urine, peritoneum contained excess of fluid; slight œdema of chest wall; liver and spleen enlarged; decomposition commenced	Liver	P	Overgrown	P	Plague.	
				Spleen	P	,,	...		
				Right inguinal glands	P	,,	...		
21	5 ,,	,,	Bubo of right inguinal glands; hæmorrhages in skin, liver, spleen, kidneys, suprarenal bodies, stomach and intestines, heart, and lungs; bladder contained blood-stained urine; excess of fluid in peritoneal sac; liver and spleen enlarged	Right inguinal glands	P	...	P	Plague.	
				Liver	P	...	...		
				Spleen	P	P	...		
22	6 ,,	Native Cat, *Dasyurus viverinus*, Shaw.	Bubo of left submaxillary glands; hæmorrhages in skin, liver, spleen, kidneys, suprarenal bodies, stomach, and intestines, lungs, and heart; liver and spleen enlarged; decomposition marked	Liver	N	...	N	Negative	Bacilli resembling *B. pestis* in smear; not confirmed.
				Spleen	N	...	N		
				Left submaxillary glands	Mixed	...	N		
				Heart-blood	N	...	N		
23	7 ,,	Guinea-pig, *Cavia Cutleri*, Bennet	No pathological lesions	Heart-blood	N	N	N	Negative.	
24	7 ,,	Rabbit-eared Perameles, *Thylacomys lagotis*, Reid.	Bubo of left axillary glands; hæmorrhages in skin, kidneys, suprarenal bodies; liver and spleen enlarged	Left axillary Glands	N	...	N	Negative.	
				Spleen	N	...	N		
				Liver	N	...	N		
25	8 ,,	Tiger Cat, *Dasyurus maculatus*, Kerr.	No bubo; hæmorrhages in skin and muscle, liver, suprarenal bodies, heart, glands; no excess of fluid in sacs	Heart-blood	N	N	N	Negative	Pneumonia.
				Liver	N	N	N		
				Spleen	N	N	N		
26	8 ,,	Opossum (brush-tailed).	No bubo; hæmorrhages scanty in skin, suprarenal bodies, heart	Heart-blood	N	N	N	Negative	Pneumonia.
				Liver	N	N	N		
				Spleen	N	N	N		
				Lungs	N	N	N		
27	9 ,,	Martin (bird)	No signs of disease	Liver	N	N	...	Negative.	
				Spleen	N	N	...		
28	9 ,,	Australian Eagle, *Aquila audax*, Lath.	No bubo or hæmorrhages; abscess of left thoracic region; pus cheesy	Heart-blood	N	N	N	Negative.	
				Liver	N	N	...		
29	9 ,,	Indian Antelope, *Antilope cervicapra*, Linn.	Left inguinal glands enlarged, and surrounded by sanguineous œdema which resembled bubo; hæmorrhages in skin, liver, suprarenal bodies, and kidneys; stomachs, and intestines, heart, lymphatic glands generally; excess of fluid in peritoneal sac; marked inflammation of stomachs and intestines; decomposition very advanced	Liver	P	N	N	Plague ...	Overgrown.
				Spleen	P	N	...		
				Left inguinal glands	P	N	...		
30	9 ,,	Opossum *Trichosurus vulpecula*, Kerr.	No bubo; hæmorrhages in skin, inguinal and axillary glands, liver, kidneys, suprarenal bodies, heart; excess of fluid in peritoneal sac; pneumonic patches in both lungs; decomposition marked	Liver	N	N	...	Negative	Putrid
				Spleen	N	N	...		
				Right inguinal glands	N	N	...		
				Lungs	N	N	...		

No.	Date.	Animal.	*Post-mortem* Appearances.	Bacteriological Examination.				Diagnosis.	Remarks.
				Specimen.	Smear Preparations.	Culture.	Result of Inoculation.		
	1902.								
31	10 May	Wallaby, *Macropus sp.*	No bubo; hæmorrhages in right inguinal glands (scanty), mammary glands, skin, stomach, and intestines, kidneys, suprarenal bodies, spleen, heart; excess of fluid in peritoneal and pleural sacs; liver and spleen showed numerous necrotic spots; broncho-pneumonia patches in both lungs	Liver Spleen	P P	... ...	... ...	Plague ...	Overgrown.
32	13 ,,	Mandarin Duck, *Aix galericulata*, Linn.	No definite *post mortem* signs	Liver Spleen	N N	... ...	... ...	Negative	
33	13 ,,	Guinea-pig, *Cavia Cutleri*, Bennet.	*Post-mortem* signs of pneumonia; no indications of plague	Lungs Liver Spleen Heart blood	N N N N	... ...	... ...	Negative.	
34	13 ,,	New Guinea Monitor, *Varanus sp.*	Abscess in anal region; no indication of plague	Liver Spleen	N N	N ...	N ...	Negative.	
35	14 ,,	Syrian Goat, *Capra hirsus (var.)*, Linn.	Abscess in left submaxillary region; no hæmorrhages; pneumonic areas in lungs; had been sick for three weeks	Spleen Liver Lungs	N N N	N N N	N N N	Negative.	
36	14 ,,	Opossum, *Trichosurus vulpecula*, Kerr.	No bubo; hæmorrhages in right and left inguinal and axillary glands, liver, suprarenal bodies, kidneys, heart; excess of fluid in peritoneal sac; slight inflammation of stomach and intestines; pneumonic patches in both lungs	Liver Spleen	N N	N N	N ...	Negative.	
37	16 ,,	Macaque Monkey, *Macacus sp.*	No bubo; hæmorrhages in liver, kidneys, and suprarenal bodies; pneumonic patches in lungs; slight enlargement of mesenteric glands near caecum	Liver Spleen Mesenteric glands	N N N	N N N	N	Negative.	
38	17 ,,	Axis Deer, *Cervus axis*, Erxl.	No bubo; hæmorrhages in skin, right inguinal, axillary and mesenteric glands, liver, kidneys, suprarenal bodies, 4th stomach, intestines, and heart; excess of fluid in peritoneal sac; serous œdema under skin of ventral surface; decomposition marked	Liver Spleen Lungs Right inguinal glands	N N N N	N N N N	N	Negative.	
39	21 ,,	Macaque Monkey, *Macacus sp.*	No bubo; hæmorrhages in suprarenal bodies; slight enlargement of mesenteric glands near cæcum; decomposition marked	Liver	N	Overgrown	...	Negative.	
40	24 ,,	Flamingo, *Phoenicopterus roseus*, Pallas.	No definite *post-mortem* signs	Liver Spleen Heart blood Muscle	N N N N	N N N N	... ...	Negative.	
41	2 June	Magpie, *Gymnorhina tibicen*, Lath.	Acute enteritis	Liver Heart blood	N N	N N	... ...	Negative.	
42	5 ,,	Coypu Rat, *Myopotamus coypus*, Molina.	No definite *post-mortem* signs	Liver Spleen Heart blood Right inguinal glands	N N N N	N N N N	N	Negative.	
43	7 ,,	Guinea-pig, *Cavia Cutleri*, Bennet.	Bubo of right inguinal glands; hæmorrhages abundant; superficial left glands generally; skin, muscle, mammary glands, stomach and intestines, liver, spleen, kidneys, suprarenal bodies, heart, lungs; excess of fluid in peritoneal sac; extravasation of blood into epicardium; liver and spleen enormously enlarged and showed numerous necrotic spots; similar spots in deeply congested broncho-pneumonic lungs	Liver Spleen	P P	P P	... ...	Plague ...	
44	7 ,,	Guinea-pig, *Cavia Cutleri*, Bennet.	Bubo of left inguinal glands; P.M. signs otherwise same as in No. 43		P	P	...	Plague ...	
45	10 ,,	Guinea-pig, *Cavia Cutleri*, Bennet.	Bubo of submaxillary region; hæmorrhages in skin, muscle, liver, kidneys, suprarenal bodies, heart; excess of fluid in peritoneal sac; spleen enlarged and showed abundant miliary speckling; pneumonic patches in lungs	Spleen	P	P	...	Plague ...	

170. From the preceding table it appears that the verified deaths from plague among the caged animals occurred as follows :—The first verified death happened on 12th April. During the next 28 days 7 others occurred, and they were separated from the first verified death and from each other by successive intervals of 12, 3, 8, 4, and 1 days. A long interval of 28 days then occurred, during which certain animals died in a number much above the usual average, though not of ascertained plague. Then one of the keepers was attacked (case 135, 5th June) with, and died (8th June) of, plague. The outbreak ended about the same time with three further deaths of animals from plague; these occurred among a small cageful of guinea-pigs on June 7 and 10.

171. Here it may be conveniently pointed out that susceptibility of marsupial animals to plague has now been noted for the first time. Natural infection of caged guinea-pigs has been noted in India.* Another observation worth recording here is the presence of buboes in most of the 11 caged animals which died of plague; our experience being that naturally infected rats never exhibit buboes. The cause of death of the first of them was determined by examination of the liver, which alone was submitted for examination; entire carcases were available in 10 other instances. Of these, 5 showed buboes in the left inguinal, 3 in the right inguinal, and one in the submaxillary glands, while the tenth had the disease in the septicæmic form, and exhibited no enlarged glands. These proportions and distribution were similar to those we have observed in man.

172. Here, then, we have an instance of infection with plague not merely of man, but also of lower animals other than rats. Only a minority of the animals was attacked, just as one only out of the 25 or 30 men working among them was attacked. The man who suffered was not a member of the cleansing-staff, but a keeper who, therefore, would appear to have been less exposed to danger than many others were who, nevertheless, escaped. Again, there was here a long interval of 28 days in the course of the epizoötic among the caged animals, just as we have seen long intervals occur in the course of epidemics (between cases 1 and 2, 1900; cases 1 and 2, and 2 and 3, 1902; on the Paddington and on the Alexandria areas, &c., &c.). These coincidences seem to betoken a similarity between the secondary causes of epizoötic and of epidemic plague. As to epidemic plague, such irregularities can be accounted for by reference to that secondary cause which consists in dissemination of the infection by rats; and I have attempted to induce the reader to observe that some of the more remarkable features of epidemic plague depend upon, and can only be explained by, the capricious way—irregular both in time and in place—in which infected rats gradually become distributed over populous areas which are covered with solidly constructed buildings. Does a similar explanation apply to the peculiar features of this outbreak of plague among caged animals other than rats? In order to answer this question the state of the Garden as to presence of rats, and as to occurrences of plague among them, must be examined.

173. On 21st February (case 25) a complaint had been made that the Garden was badly infested, and was a danger in relation to plague, by one of the public. The Board directed inquiry, and was informed that the place was believed to be comparatively free from rats; this information was unexpected, and afterwards turned out to have been incorrect.

174. On 7th May I examined every member of the Garden staff as to his experience with rats there; but it should be noted that the Superintendent alone slept on the premises, and alone, consequently, had opportunity of observing after sunset when rats were most likely to be visible. The Superintendent said that he had seen increased numbers towards the end of February, but added that during the long term of his superintendency he had noticed fluctuations from time to time, and he declined to attribute any special importance to the increase mentioned. Nevertheless, it appeared from his books that he had purchased an additional supply of traps on 5th March. One of the keepers also said that he had noticed an increase about that time, and had occasionally seen one or two dead rats lying about. Another keeper, whose business it was to attend to some birds, pademelons,

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* The Bombay Plague: Compiled under orders of Government by Captain J. K. Condon, Indian Staff Corps. Bombay 1900, page 122.

kangaroos, and wallabies, which were kept in that corner of the grounds where the first deaths among the animals occurred, said that about the time the illness among the marsupials began he had found dead rats, 3 carcases one day, and 2 on another; and this was so unusual a circumstance that he at once reported it to the Superintendent (the Superintendent would not deny, but could not remember, that he had done so). Another keeper, who looked after the elephants and camels in another part of the grounds not far from the slaughter-house, said that, although he had been employed at the Gardens for six years, he had never seen more than a few rats altogether (that is, it will be remembered, by day); but that about commencement of the mortality among the caged animals he had come across a sick rat one day, which he had had no difficulty in stamping upon and so killing. The remainder of the staff, several of whom had been employed for many years, none for less than three, were unanimous in saying that they had not seen many rats at any time, and that they had never, or very rarely indeed, seen a single dead one. There is thus some evidence that one keeper had seen dead rats in unaccustomed number about the time the sickness among the caged animals began, and that somewhere about the same time another keeper saw an apparently sick rat in the open in the daytime.

175. A rat-catcher who had been detailed to secure specimens on 15th April had had very little success, though an experienced and trustworthy man. Between that date and 21st April, when systematic cleansing began, he had been able to submit only two rats, both of which were quite healthy.

176. Specimens were first submitted by the cleansing staff on 23rd April, and down to 3rd May it had forwarded 21 rats, none of which yielded any evidence of infection with plague on being examined in the laboratory. Down to this date the cleansing which had been done had been on the surface; rubbish had been collected, the soil of enclosures had been treated with carbolic acid, and cages and housing-sheds had been sprayed with hot lime-wash: but then some cages began to be moved so as to expose the soil beneath them. As soon as this was done considerably larger numbers of rats were discovered; and 2 out of 7 thus taken on May 3rd were ascertained to have died of plague. So also on 4th May, out of 3 rats one, on 5th May out of 5 rats 3, and on 6th May out of 31 rats 8 were ascertained in the laboratory to be infected with plague. The fact that, notwithstanding superficial appearances and inaccurate information, rats did infest the Garden in large numbers, and that plague was epizoötic among them, having been thus established, routine transmission to the laboratories of all carcases found was intermitted. Hence, although on moving cages and on digging out burrows they continued to be found in numbers, plague was not further demonstrated among them (was not looked for among them) until 7th June. A week or so prior to that date the yield of rats had fallen off, and had almost ceased; and, as has been mentioned already, no verified death from plague had been noted among the caged animals since 10th May, so that there was reason to hope that the infection had been cleared away. But immediately prior to 7th June fresh burrows and fresh carcases of recently deceased rats began to be seen again; they were observed under, and in the immediate neighbourhood of, a cage containing about 20 guinea-pigs. Smoking-out of the burrows with sulphur fumes, and digging-out, were again resorted to, and plague was again demonstrated in 3 of the rats then caught, as well as in 3 of the caged guinea-pigs which died between 7th and 10th June. The total number of rats examined in the laboratories was 76, and it was possible to identify plague in 19 of them.

177. It was thought that this falling off must have been due to some imperfection in the mode of search to that time followed, or to some incompleteness, but, nevertheless, that nearly all the rats and plague-rats must have been destroyed. But this was uncertain; it was therefore resolved that the surrounding fence should not merely be made good as regarded certain holes in it, but that it should be sunk beneath the soil to a depth of at least 2 feet all the way round, so that any rats which might remain should be confined to the enclosure, and so that outside rats should be unable to enter. This work having been speedily carried out, and all detected burrows having been smoked out or dug up without any more plague-rats having been discovered, it was thought that the Garden was free from infection, and permission to reopen it was given on 18th August.

178. It has already been mentioned that one of the keepers contracted the infection. He attended to some of the larger carnivora, of which the cages were on the same side as the guinea-pig cage, though 90 yards away from it; he was attacked on 5th June, and therefore had probably received the infection about 2nd June. He continued to be employed at his own work while the cleansing was going on, so that it would seem that many men (members of the cleansing-staff) had run much greater risks. The following are the particulars of his case:—

Case 134.—B.B., 24, m., single; a keeper at the Zoological Gardens, where he had been employed for three years and down to date of attack. His duty was to feed and clean some of the larger carnivora, wolves, wombats, and Indian swine. He had worked daily, Sundays included; occasionally he had done a little gardening, but not for several weeks before his illness. He lived at a house half-a-mile away, and left the Garden at night-fall. He was attacked at 3·30 on the afternoon of 5th June, with violent shivering, colic, vomiting, and diarrhœa. His case was reported about midday on 6th June, and he then exhibited a left inguinal bubo; presence or absence of wounds in relation to the bubo was not noted. In view of the circumstances I directed bacteriological examination of liquid withdrawn from the bubo to be made, and both morphological and cultural tests yielded positive results. He was removed the same day to hospital, and died 8th June. Specially careful examination was directed to be made of the house at which he lived. There were mouse-eaten holes in skirting boards on the ground-floor; all ground-floors were raised, but no traces of rats were found. Rat-catchers were told off to catch rats on the premises, but failed. The other inhabitants said that similar efforts had been made without success a few weeks before by rat-catchers in employment in this neighbourhood by the Local Authority for the City. At this house there were three contacts; there were no further cases, either there or at the Garden.

179. B.B. had had no communication with any previous case of plague, according to the result of inquiries on this head.

180. How had the Garden become infected? The larger carnivora were fed on horses which were slaughtered on the premises. The rest were fed on fodder which was furnished by a contractor, who procured his supplies by rail from the country; they were not distributed from his place of business in the Darling Harbour area, but were purchased by the Superintendent on the trucks in the railway yard, and were carted thence direct to the Garden. The same, I was informed, might be said of the maize, bran, pollard, potatoes, barley, and chaff, which formed other part of such supplies. Lastly, carrots, greenstuff, bananas, and some bread were supplied by a Chinese gardener at Botany. The information on these points was not precise, and probably represented merely the general rule.

181. The house nearest to the Garden at which a case of plague occurred stood 16 chains away. This was Case 100, and it occurred in a school boy who was attacked 18th April; he exhibited a left inguinal bubo; morphological and cultural tests positive; recovered. The house in which he lived with his parents was in bad sanitary state, and in poor repair; there were stables close to it; it offered every evidence of present infestation with rats; the inhabitants said they had complained to the Local Authority before the child's illness of bad smells in it as from dead rats, and the disinfecting staff removed 3 carcases from beneath the floors when they came to raise them. The nearest house beyond this at which any case of plague occurred was 60 chains away to the south-west, the next 84 chains away to the north-west; all others were still more remote, and the intervening country entirely covered with buildings. The nearest point at which a plague-rat had been taken was 72 chains away to the south-west. The patient was said not to have been away from his neighbourhood for many days before his attack, except on 6th April, when he had paid a visit to the Zoological Garden; but this, supposing the date correct, was 12 days before his attack, and, consequently, from 7 to 9 days before the date of his infection.

182. It thus seems possible that the last-mentioned patient's house became infected by invasion of plague-rats from the Garden, but also that the Garden was infected by invasion of city rats which travelled towards it across the area on which that house stood. If the latter had happened, it would be singular that no cases of plague in man, except this one, should have marked the progress of the rats, while on the other, it would not be surprising if migration in the contrary direction should have given rise to this one case alone. On the whole, our experience inclines us to favour the supposition that the Garden was infected first, and through imported fodder; but conjecture alone is possible.

DESCRIPTION OF A SINGLE INDIGENOUS CASE AT THE CITY OF NEWCASTLE.

183. Newcastle is situated at the mouth of the Hunter River, in S. latitude 32° 57′, 70 miles north of Sydney by sea. The population of the city municipal district was 14,250 at the Census of 1901, that of the city and adjacent suburbs 32,225. The tonnage entered during 1901 was 1,573,683. The principal occupation followed was coal-mining. One case of plague had been met with on a vessel in the port on 17th March (or five months before) which was imported from Sydney, and which has been elsewhere described (see p. 15).

184. T. O'N., 19, male, single, a native of this State, had been employed at the Criterion Hotel as cellarman and porter for four months; he had not been away from the neighbourhood during that term. He was quite well until he was suddenly attacked during the afternoon of 3rd August with severe headache, chilliness, and pains in the limbs. He went to bed, and on 4th August was visited by a medical man who advised his removal to the general hospital, where he was admitted the same day. During the ensuing night he was delirious, and on the morning of 5th August he had a temperature of 104°; he was seriously ill but nothing could be discovered to account for his condition. During the evening he first complained of pain in his left leg, and later an acutely tender swelling was observed in the left chain of femoral glands. Early on 6th August the case was reported to the Medical Officer of Health for the Hunter River Combined Sanitary Districts (Dr. Robert Dick, M.B., D.P.H.). Dr. Dick at once telephoned to the Department his clinical opinion that the disease was plague, and the Assistant Medical Officer of the Government (Dr. R. J. Millard, M.B., D.P.H.) was despatched to Newcastle to consult on the case with him. He arrived during the evening, and on the 7th expressed his concurrence with Dr. Dick's opinion. At a later hour Dr. Dick was able to report that the morphological and cultural tests which he had applied to liquid abstracted from the enlarged femoral gland had both yielded positive results, and afterwards that a guinea-pig which had been inoculated with a part of the same liquid had died of plague. Nurses having experience of plague were at once sent up, and all arrangements for transferring the patient to the Maritime Quarantine Station at Stockton were completed; but at the same time he grew rapidly worse, and he died at the general hospital on 7th August. The body was coffined with the precautions already described (Report, 1900, p. 21), and was buried on the Maritime Quarantine ground.

185. The Criterion Hotel was closed on 6th August, as soon as Dr. Dick's message had been received. It was placed under a police-guard instructed to prevent ingress of all but members of the household and lodgers. Dr. Dick was desired to obtain a list of names of all then living at the hotel, and to ascertain whence they had come; and as soon as all had been collected to inform them that they would be allowed to leave, but to permit none to go until their effects had been disinfected and their professed destinations ascertained. The licensee's family numbered 6, his servants 10, and the lodgers 18. The latter were almost all of them commercial travellers, and none had been out of the State for a long time past; many of them resided in Sydney, and none had had any discovered connection with plague there, where the last case had been notified two months before, on 12th June. All the visitors but one left on 7th August; no case occurred among them or at the hotel. As soon as the particulars mentioned had been ascertained egress and ingress were allowed to the occupants without any restriction.

186. After a preliminary inspection of the premises on the evening of 6th August, the Medical Officer of Health had reported the finding of a dead rat in a state of decomposition too far advanced for any useful examination, and that the licensee had said that shortly before T.O'N.'s illness he had found other dead rats. On 7th August the foreman of the Departmental rat-staff was directed to proceed to Newcastle, there to gather together a local rat-staff of twelve men, who were to catch rats in such neighbourhoods as might be pointed out from time to time by the Medical Officer of Health. Chief Sanitary Inspector Getting was also directed to proceed to Newcastle on the same date, taking with him apparatus and material necessary for immediate disinfection of the patient's room and the lodgers' luggage. He was accompanied by Temporary Sanitary Inspector Lobb, previously employed on similar duty at Sydney, and he was instructed to gather together a scavenging staff for cleansing of the premises, and of the neighbourhood afterwards.

187.

187. At the same time the Mayor of Newcastle, as representing the Local Authority under the Public Health Act, for the City of Newcastle (with whom the Medical Officer of Health had already communicated), was officially informed of the nature of T.O'N.'s disease, and of the arrangements made for obviating the danger to which the city was exposed; and his assistance in furnishing labour and materials was requested. An advertisement was also forwarded for insertion in all the Newcastle newspapers, in which medical practitioners were requested to be good enough to refer doubtful cases with which they might meet to the Medical Officer of Health.

188. On 8th August, the hotel was occupied by the cleansing-staff. It was a large three story brick building, which stood at the corner of Hunter and Bolton streets, in the centre of the business part of the city. As a whole it was clean and well kept, and there were no signs of rats on the upper floors. But a large cellar under the bar was very dirty. It had a poor concrete floor, which was undermined by rats in all directions, and considerable quantities of rats' dung and rat rubbish afforded abundant evidence of recent infestation. It contained two shallow wells, apparently designed to collect subsoil waters draining from a steep rise on which the hotel stood; the upper well overflowed into the lower. The overflow from the latter escaped by an untrapped 9-inch e.w.g. pipe, which ran underground straight down the hill to the harbour front, where it discharged under wharfs at a distance of 9 or 10 chains from the hotel. This cellar was the principal place at which the patient was employed during the day; and it was learned that he had removed 8 dead rats from it shortly before he fell ill. During the cleansing 4 other carcases were discovered in it, but they were all too far advanced in decomposition for bacteriological examination. No live rats were observed.

189. At the wharves under which the drain discharged very large quantities of fodder had been landed during several previous months, either from ships or from the railway which ran along them; this had in large proportion been sent up from Sydney for transmission to the north, where it was wanted in consequence of a prolonged drought. It was almost or entirely the produce of this State, heavy duties having prevented profitable importations; but it had, no doubt, been exposed to incursions of rats during its collection at Sydney, where the last discovered plague rat had been taken on 11th July.

190. As soon as cleansing of the hotel, and of an adjoining ship-chandler's shop, which as regards rats was structurally one with the hotel, had been begun, a further cleansing gang was collected and organised by the Chief Sanitary Inspector, and it was placed under immediate supervision of temporary Departmental Sanitary Inspector Lobb, who had with him the Municipal Sanitary Inspector Lloyd; they were further assisted by Sanitary Inspector Abberton, of the personal staff of the Medical Officer of Health who directed the proceedings.

191. Authority of the Executive Government had already been procured for entering and cleansing the whole of the block which included the Criterion Hotel, and in the course of the next few days this work had been completed. The Local Authority then proceeded, as advised, to make a sanitary inspection of several other adjacent blocks in that part of the city which lies between Signal Hill and the railway viaduct, a distance of about 68 chains.

192. Destruction of rats had been carried on at Newcastle prior to the events now described. During the thirteen months, 11th May, 1900, to 8th June, 1901, a capitation grant of 6d. had been offered, and a furnace at which the rats brought in could be burned had been provided at a convenient spot; the number then paid for and destroyed was 32,581. This arrangement was resumed on 6th March, 1902, but the capitation grant was reduced to 3d.; between that date and 16th August, 13,103 rats were paid for and destroyed. During the four weeks ending 9th August the numbers thus brought in had been 255, 167, 169, and 83. The special rat-staff organised on 8th August was utilised, not for destruction of rats (although, of course, it incidentally destroyed them), but to collect them systematically from various neighbourhoods indicated by the Medical Officer of Health, so that the state of the rat-tribe generally on the area suspected of infectivity might be investigated. It began work on 8th August, but was not at its full strength of twelve men until 13th August. Between 8th August and 11th September it collected

rats from 125 different premises which were well distributed over the whole area, many of them having been revisited several times. The number of rats collected was 1,598, and all were examined by the Medical Officer of Health. Two carcases alone gave ground for suspicion of plague; but the usual tests which were applied both by the Medical Officer of Health and by the Micro-Biologist to the Board of Health failed to establish presence of the disease. It must, therefore, be recorded that no plague-rats were found at Newcastle. Nevertheless, for reasons which have already been given above, it cannot be affirmed that there were no plague-rats there; and it is a significant fact both in relation to infection of T.O'N. and to arrest of it after occurrence of that single case, that no rumour of unusual mortality among the rats of any part of Newcastle was heard during the investigation, except at the Criterion Hotel.

193. No further cases of plague occurred, nor were any cases which presented good grounds for suspicion subsequently reported to the Medical Officer of Health.

DISTRIBUTION OF CASES AMONG PLAGUE-HOUSES.

194. We are now in a position to examine the facts in relation to possible direct or indirect communication of the disease from man to man as a cause of the epidemic prevalence of plague more closely. The question, indeed, was examined fully in relation to the first epidemic (Report, 1900, pp. 31-33), and was in the clearest way answered in the negative; it will be well, nevertheless, to go over the evidence yielded by the second epidemic in order that this contribution to the ætiology of plague may be complete in itself, as far, that is to say, as it goes.

195. The following general statement has reference to houses which *harboured* cases, without regard to their having been or not having been the adjudged place of infection of such cases. The epidemic consisted in 139 cases; the patients inhabited 124 premises (including one ship); 15 out of the 139, therefore, were secondary cases. As the 15 secondary cases occurred on 9 premises, it follows that 115 separate premises (including one ship) harboured a single case apiece, and no more. The interval between attack and removal, or the number of days during which these 115 patients remained at home and in contact with the other members of the households to which they belonged was as follows:—

TABLE XX.—Showing the number of days after attack during which 115 primary-and-single cases remained in contact with the rest of the household to which they belonged:—

Removed on the day of attack	2
,, one day after attack	20
,, two days ,, ...	24
,, three ,, ...	24
,, four ,, ...	17
,, five ,, ...	8
,, six ,, ...	4
,, seven ,, ...	3
,, eight ,, ...	3
,, nine ,, ...	2
,, ten ,, ...	3
,, eleven ,, ...	1
,, twenty-three ,, ...	1
,, twenty-six ,, ...	1
Not removed	2
Total	115

Whence it appears that these 115 patients had, for the most part, opportunity of communicating their disease. Table XX corresponds with Table XII, Report 1900, p. 33, which is to precisely similar effect. Communication of the disease from person to person, if it ever occurred at all, was a factor of no importance whatever in production of the epidemic. We have, however, to examine the circumstances under which the 15 cases mentioned above occurred secondarily to, and on the same premises as, 9 primary cases.

CIRCUMSTANCES

CIRCUMSTANCES UNDER WHICH FIFTEEN SECONDARY CASES BECAME INFECTED.

196. The datum for examination of the circumstances under which secondary cases received their infection, with reference to the possibility of their having got it from the primary case, is the time at which the primary case fell ill.

TABLE XXI.—Showing the dates on which nine primary cases began, and the dates on which fifteen cases secondary to them began.

Group.	Primary cases.—Numbers and dates of attack.	Secondary cases.—Numbers and dates of attack.
A	(3) Jan. 10–11	(5) Jan. 16.
B	(6) Jan. 19	(8) Jan. 20.
C	(24) Feb. 18	(30) Feb. 21.
D	(26) Feb. 19	(29) Feb. 21; (27d*) Feb. 22; (32d) Feb. 22; (31d) Feb. 23; (39) Feb. 24; (40) Feb. 25.
E	(35) Feb. 22	(45d) Mar. 1.
F	(52) Mar. 11	(53) Mar. 11.
G	(82) Mar. 21	(92) Mar. 29.
H	(85) Mar. 27	(91) April 2.
I	(112d) April 27	(117d) May 3; (126d) May 15.

* d = died.

197. *Groups A and B* (Paddington area).—These have been described elsewhere (see p. 22). Here only the following points need be mentioned:—First, Cases 3 and 5 of Group A were, of course, in intimate contact for ten or nine days of duration of Case 3; but the latter exhibited a right inguinal bubo, was at no date seriously ill, and recovered. Cases 6 and 8 of Group B were in contact for about twenty-four hours of duration of Case 6; the latter exhibited a left inguinal bubo, and recovered. Additionally, one or both of the patients constituting Group B had visited Case 3 one or more times. Secondly, the two groups occurred in adjoining cottages, which were separate for man, but structurally one for rats infesting either; and both were structurally one by the space under the floors with a third adjoining cottage, at which, as well as at the other two, it is known that a fatal disease prevailed among the rats infesting it.

198. *Group C* (Woolloomooloo area).—First, it must be assumed that there was free communication between Case 30 and Case 24 during the three days which elapsed before the latter was removed, since, although they belonged to different families, both inhabited the same small house. But Case 24 exhibited a left femoral bubo, and ended in recovery. Secondly, the house at which both lived was badly infested with rats, which, also, had recently died in numbers of disease; thirteen had been found dead between 15th and 17th February—four of them under the kitchen floor, one in the water-closet. Now, Case 24 was probably infected on 16th February, but the illness was not notified till 21st February; this was the day Case 30 was attacked, prior to which no cleansing had been done.

199. *Group D* (Criterion Hotel, Central area).—This group, according to Table XXI, consists of seven cases; but Case 27 was not secondary to Case 26, nor the remaining five secondary to Cases 26 and 27, for these two patients had left the hotel (where they had lived) before they fell ill. They are retained in the Table below partly to avoid confusion, but mainly for the sake of the light they shed on the true nature of the relationship between Case 29 and the remaining four. The following Table conveniently sets forth the important points. It is only necessary to emphasise the facts that Case 26 had acted as a temporary barmaid at the hotel, sleeping on the premises, from 10th February to 17th February; she had left in good health on the latter date, and was taken ill two days later at a house in a neighbourhood free from suspicion of infection, and without having had any further communication with the six later cases; and that Case 27, who had lodged at the hotel for several months before, left it on 19th February in good health for another hotel (which has never been suspected of infection), where she was attacked three days later.

TABLE XXII.—Showing the dates on which the seven patients who constitute Group D were attacked, notified, removed, and recovered or died; together with the situation of the buboes they exhibited.

Case No.	Sex.	Attacked.	Notified.	Removed from "Criterion."	Clinical form.	Situation of bubo.	Date of—	
							Recovery.	Death.
26	F	February 19	February 22	Had left 2 and 3 days before the attack.	Bubonic	R. inguinal	March 18	....
27	F	" 22	" 22		"	R. cervical	....	March 2
29	F	" 21	" 22	February 23	"	L. femoral	March 24	....
31	F	" 23	" 24	" 26	"	R. inguinal	....	Feb. 27
32	F	" 22	" 24	" 25	"	R. inguinal	....	March 1
39	F	" 24	" 24	" 26	"	L. femoral	April 7	....
40	M	" 25	" 26	" 26	"	L. inguinal	March 27	....

200. It must be assumed that there was communication between Cases 29, 31, 32, and 39 after attack of Case 29, since they were all women living at the same hotel; but Case 40 occurred in a cellarman, and it is not likely he saw any of the women after they had been attacked. Nothing is known on this point. What were the other circumstances?

201. The premises were the Criterion Hotel and Theatre They consisted of a fine corner block, four stories high, with a basement, of which part of the ground floor frontages was let as shops, &c. The three upper floors were clean. The ground floor and basement were in bad repair and dirty. These latter were ceiled and floored with wood, and subdivided with wooden partitions. When cleansing began and the partitions and linings were torn down, enough dung and rat's rubbish (paper, bones, rags, &c) were removed to nearly fill two large scavenger's carts. Provision for drainage was inadequate, several inches of water having been found standing under the false floor of the ill-lighted and ill-ventilated compartments in the basement, some of which served as sleeping apartments for the servants. A similar state of things existed under the flooring of the first floor as regards rat's dung and rat's rubbish, of which large quantities were removed from between the joists. Upper floors had been gnawed through by rats at many points. From different parts of this building about forty-five dead rats were taken—from behind lining-boards and from under flooring boards in the basement; beneath kitchen, scullery, and pantry floors; from under a bedroom floor near a dining-room on the first floor; and from under three bedroom floors and a passage floor on the second storey. A bar-floor was riddled with rat-holes, and three carcases were taken from a box-seat behind the bar, another from under the counter, another from an adjacent urinal. All these carcases were too putrid for bacteriological examination, and no live rats were encountered; hence plague was not shown to have been the cause of this unusual mortality, which clearly had occurred during a few days only, since the carcases were in about the same stage of putridity. But plague was at this date present among the rats of the neighbourhood (*see* Central area, par. 133).

202. It is now apparent that the bond between Cases 26 and 27 severally and the remaining five was residence on these premises, and nothing else; for they were only attacked two and three days respectively after having left them for lodgings to which no suspicion of infectiveness at any time attached—one of them two days before Case 29, which was the first of the subsequent series. Next, it can be pointed out that Case 29 began 21st February, and that the four subsequent cases followed at intervals of one, two, three, and four days; but Case 29 not only exhibited a left femoral bubo and recovered, but also was removed within forty-eight hours of her attack. Note that Case 40 had in all probability received the infection on or before that date on which very energetic cleansing and disinfection of these premises had begun—namely, late on the afternoon of 22nd February.

203. *Group E* (Alexandria area).—Case 35 exhibited a left femoral bubo, and ended in recovery; during four days of its duration, Case 45 was in free communication with the patient. The house was a two-storey brick cottage in poor repair, where a pawnbroker's business was carried on. On being cleansed, large quantities of rat's rubbish and droppings were removed from beneath the floors which, as well as the skirting-boards, were full of rat-holes, but no carcases and no live rats were seen. There were many burrows in the yards, none of which were dug out. The neighbourhood was infected (*see* Alexandria area, par. 108). The second case may either have received its infection from rats which had been left in the burrows, or the house may have been reinfected from the neighbourhood after such cleansing as was done.

204. *Group F* (Central area).—The patients were a pantryman and a waiter employed at the Central Exchange Coffee Palace for a considerable time before attack. Both fell ill on the same day, one having been suddenly attacked " while at work," the other at 10 p.m. The premises were very extensive and constituted one end of a city block, having, consequently, frontages to three streets. The greater part of it was occupied by an hotel and by a photographer; other part as offices; the frontages at street level as shops. All parts of the building were in structural communication, so as to be free to rats. Sewerage was defective. A well, intended to light inner rooms of the building, had been filled with staging and covered over; the roof had been extensively built upon by the photographer, who had erected a very large number of rooms of odds and ends of wood, and had even built on the top of them again, the whole being full of lumber, dirt, and rubbish, except some filthy places in use. On cleansing, most parts of the building were found to be infested with rats, and large numbers of carcases, as well as nests, rubbish, and some live rats, were removed, but no plague-rat was identified. The two patients were partly employed in the basement, but slept in a kind of loft which was much overcrowded with ten other servants, and dark at midday. On the night they were taken ill, eighty people slept at the hotel, but no other cases occurred (but *see* Table XVII, in which Cases 60 and 69 are doubtfully ascribed to this building, which they visited regularly as an eating-house). There was here no possibility of communication of infection from Case 52 to Case 53 (nor from either of them to Cases 60 and 69, since the latter only went to the hotel about midday, while the former were suddenly attacked at night and incapacitated, and were removed during the forenoon of the next day, when, also, the building was closed to visitors).

205. *Group G.*—The first patient (Case 82) was a wharf-labourer in irregular employment; he fell ill 21st March, but worked on 24th and 25th March notwithstanding; he exhibited a left inguinal bubo, smears and cultures negative, and recovered; was removed to hospital, 27th March. The second patient was his son, aged 6, who fell ill eight days after him, and two days after his removal; glandular swellings, bi-cervical, acutely tender (slight reddening of fauces; no exudation) and bi-inguinal, of which slight tenderness on one side only; bacteriology, none; recovered. No note as to state of premises, which stood on the Chippendale area, the house being close to Jones's produce store at the back (*see* par. 84).

206. *Group H.* (*Pyrmont area*)—This was composed of Cases 85 and 91, mother and son. Case 85 was attacked 27th March, at 11 a.m.; left femoral bubo, smears and cultures negative; recovered; removed to hospital, 29th March. Case 91 occurred to the son, who was a printer's boy; no suspicion attached to his place of employment, which was carefully examined. He was attacked 2nd April, during the morning

at his work, six days after his mother, and four days after her removal; left femoral bubo, which appeared within four hours of onset; bacteriology, none; recovered; removed on day of attack. The cottage was cleaned on 29th March, the day Case 85 was removed; on taking up floors abundant signs of present infestation were found and much rat's rubbish removed, but no carcases; at least one dead rat had been found by the family a few days earlier. Next door to this house Case 83 had occurred 26th March. The patient was a labourer; he had a left femoral bubo, and a small reddened patch on the left instep, no pustulation; bacteriology, none; removed 27th March. A dead rat had been found by the patient a week or two before, but no carcases were found by the disinfecting staff. Case 85 was acquainted with this man, but said she had not been in his house for a week before his illness—a matter of little importance, true or not true, on account of the nature of his case and of his removal within twenty-four hours of his attack. But it seems that the disinfecting staff had not raised the floors at his house; for on occurrence of Case 91 they did this, and reported presence under them of every sign of continued infestation with rats, though they found no carcases. These three cases occurred on the Pyrmont area. On 26th March a plague-rat had been taken from the yard of a State school situated 160 yards away from these two cottages to the south-west, and three plague-rats were taken at Buckle's wharf on 7th, 8th and 10th April, which lay about 380 yards away from them to the west. No other case occurred within three-quarters of a mile of the cottages except Case 78, attacked 24th March at a rat-infested timber-wharf where many dead rats had been found; and Case 99, attacked 17th April, and Case 124, attacked 6th May, both at Buckle's wharf just mentioned.

207. *Group I.*—This consists of Cases 112, 117, and 126, which occurred in Chinese, all of whom died. The first of them was a man employed at Hop Lee & Co.'s produce store, 26, Campbell-street, on the South-Central area (and already mentioned, see par. 100); he was attacked 27th April, had the disease in septicæmic form, and died before notification at the entrance to Sydney Hospital to which he was in course of removal by his friends. Case 117 was attacked 3rd May; was admitted to the Royal North Sydney Hospital from a Chinese garden on that side of the harbour; his case was notified on 7th May, on which day, also, he died. He had pneumonia on admission and a submaxillary bubo, smears and cultures positive. This man had frequented Hop Lee & Co.'s during the week before his attack, and there seemed to be no doubt that he had also slept there; he was thus on the premises during illness of Case 112. Case 126 was attacked 15th May; the patient was taken to Sydney Hospital 16th May, but died on the way; nature of illness verified *post-mortem* under Coroner's order. This man was employed at Hop Lee & Co.'s. On notification of Case 112, the store was visited by the disinfecting staff, and was found to be well-constructed and in good order, but there were ill-lighted and ill-ventilated cubicles within the building, and more on the flat roof of a stable in the yard; abundant traces of present infestation with rats were found, but no carcases. The Local Authority for the city was advised to secure removal of the cubicles, but this was not done at that time owing to some misunderstanding. On occurrence of Case 118 the store was not revisited, for this patient's connection with it was not made out until after occurrence of Case 126; but it was revisited on occurrence of the latter, and although, again, no carcases were discovered, abundant signs of continued infestation were observed, and especially fresh droppings among pea-nuts stored over some of the inside cubicles. It has already been noted that a plague-rat was taken at a public-house six doors removed from this store on 22nd April (see par. 100).

208. These facts require no comment. It need hardly be pointed out that Group G presents elements of doubt as to the nature of the two cases, though the diagnosis was made and was confirmed by two physicians acting independently, both of whom had had long clinical experience of the disease; still it is to be regretted that no bacteriological check was applied to the second of them. In Group H the clinical signs were decisive; the negative result of the bacteriological examination which was made in Case 85 only was probably due to some accident, such as failure of the needle to penetrate a small bubo. I proceed to describe the instances in which multiple cases occurred in connection with premises at which none of the patients resided.

CIRCUMSTANCES SURROUNDING THE INFECTION OF FOUR GROUPS OF PERSONS ASSOCIATED SOLELY BY RESORT TO THE SAME PREMISES.

209. The foregoing groups, A to I, were made up of persons who lived at the premises where all of them are adjudged to have been infected (save two persons in Group A whose cases, as already noted, properly belong to this series; see par. 199). The following groups are composed of persons who in no instance lived at the place at which they are adjudged to have received the infection, but, on the contrary, all inhabited different houses in neighbourhoods which (with one exception) were distant or even remote from it, and which were also free from suspicion of infection with plague. In other words, the sole tangible bond between the persons of which these groups are severally composed was resort during business hours to the same business premises. Group K has special interest, since of the four persons composing

it, while two were employed at the theatre which was the adjudged place of their infection, two others merely attended a performance at it. The following table displays the more important facts :—

TABLE XXIII.—Showing the dates on which persons who constitute Four Groups, distinguished solely by resort to the same business premises, were attacked, together with some other particulars.

Group.	Case number and date of attack.	Adjudged place of infection.	Nature of association at and with adjudged place of infection.	Place of Residence.	Area in which residence situated—whether infected or not.
K	(21) Feb. 12	Her Majesty's Theatre and Hotel, 186–8, Pitt-street.	Attended performance.	Nelson-st, Leichhardt	Not.
	(18) " 14		Employed	130 Reservoir-st., Surry Hills	"
	(19) " 14		Attended performance.	22 Bullanaming-st., Redfern	"
	(20) " 15		Employed	247 Church-st., Camperdown	Not till a month after attack.
L	(34) " 24	Siddaway's Boot Factory, 47, Market-street.	Employed	59 High Holborn-st.	Not.
	(43) " 27		"	Bondi	"
M	(64) Mar. 14	Andrew's Printing-house, 13, Bridge-street.	"	38 Campbell-st, Balmain	"
	(65) " 15		"	14 Phelps-st., Surry Hills	"
	(66) " 16		"	26 George-st., Erskineville	"
	(71) " 16		"	Bexley	"
	(70) " 17		"	Kogarah	"
N	(99) Apr. 17	Buckle's Wharf	" Frequented Buckle's Wharf.	6 Ultimo-st., Ultimo	Yes.
	(123) May 6			289 Riley-st.	Not.

210. *Group K (Central area).*—Her Majesty's theatre and hotel. The premises were very large, and had frontage to Pitt and to Market Streets. The theatre and the hotel were in communication for man only by a bar which was open to the latter on one side, to the dress circle on the other. This was not used as a passage. But for rats, these two establishments were practically one.

211. Case 21 occurred in a woman who was attacked 12th February, and who lived in a suburb 3 or 4 miles away, at a brick and weatherboard cottage, which was in fair repair, very clean, and free from all traces of infestation with rats. The patient said she had not been away from the neighbourhood of her dwelling for a long time prior to her attack, except 10th February, when she attended an evening performance at the theatre with her husband ; they then sat in that part known as the family circle. No "indigenous" case occurred at any time within a mile of her residence.

212. Case 18 occurred in a boy who was regularly employed at the theatre, and who was attacked 14th February. His chief duty was to clean bottles and to keep in order a store-room at the back of the gallery next above the family circle, and in the evening to attend at a refreshment bar at the back of the family circle ; he also sometimes helped to clean the auditorium. He went to this work at 7·30 a.m., continued till 4 p.m., went home and returned for the evening performance at 8 p.m., lastly getting home to bed at about 12 30 a.m. He lived in a brick terrace house, clean, in fair repair, and found to present no signs of infestation with rats.

213. Case 19 occurred in a man who was attacked 14th February. He was unemployed at the time, and from his account of his movements, which seemed to be straightforward and consistent, it appeared that he occasionally (though on what dates in relation to his illness, if any, was not made out) took food at 178, Pitt-street ; that is to say, next door to No. 180, where a plague-rat was taken on 14th February. He lived in a brick house which was found to be dirty, damp, and in bad repair, but quite free from all traces of infestation with rats. No indigenous case occurred anywhere in the neighbourhood of his dwelling. On 11th February he went to the theatre, and then sat in the family circle.

214. Case 20.—This patient, who was attacked 15th February, was employed at the theatre as a scene shifter ; he worked in the flies, and these were accessible both from the family circle and from the gallery ; he was last employed on the day of his attack. For a description of his cottage and the state as to plague of the neighbourhood in which it stood, see Camperdown area (par. 136).

215. The theatre was separated from shops to the north of it on the Pitt-street frontage by a blind lane ; the hotel kitchen was in the basement, and had a passage which led to this lane, by which wastes were taken out and deposited in boxes to be emptied by the scavengers ; but similar access to the lane could be had from one or more premises to its north. From this lane putrid carcases had been gathered on 29th, 30th, and 31st January, and on 1st, 8th, and 11th February ; and although almost unfit for bacteriological examination some of them were submitted to it. The general result was, that while morphological tests yielded doubtful, but occasionally apparently positive results, all cultures quickly became overgrown, and

all inoculations yielded doubtful and untrustworthy results. Clear *primâ facie* evidence of plague in these carcases was got on 3rd February for the first time, and this was confirmed by the results of inoculation tests on 7th February. Further, plague-rats were taken on 14th and 25th February at premises within ten doors of the lane and on the same side of the way, namely, at No. 180 Pitt-street; so that it is plain that the neighbourhood of the theatre was freely infested with rats, among which plague was prevalent. Lastly, it need not be doubted that the plague-rats taken in the lane were thrown out from the hotel kitchen, perhaps altogether, but at least in part.

216. It has already been stated that, although ostensibly separate buildings, the theatre and the hotel were practically one for rats; especially, these animals had burrows which passed from the basement of the theatre, under the party wall, into the basement of the hotel where the kitchen was. But in general respects the two premises were found to be in good order. The sewerage and all the internal fittings had been reconstructed in 1900; the theatre was clean and, except the burrows referred to in the basement; no traces of rats were found until the family circle was reached; there cushions were both moth- and rat-eaten, and two carcases were removed from beneath the staging which supported the seats. In all, eight carcases were removed from the upper part of the theatre. In the wall of the family circle there was also a chase which carried a hot and a cold water-pipe, and a waste-pipe from a bath-room in the hotel, and which contained rubbish; under the floor of the bath-room two more carcases were found. However, the hotel was also found to be in good order and very clean except the basement, which was dirty; seven carcases in all were gathered from it. Lastly, the pavement in front of the theatre and hotel in Pitt-street, where it abutted against the external walls, was undermined by rats, these having gained access from a dry area. The undermining also extended in front of the Pitt-street face of the George Hotel a quite separate building which stood on the actual corner, and which was embraced by the theatre building, consequently, on two sides; here Case 22, attacked 16th February, occurred in a handy man, and on cleansing, although the place was clean and in good order, seven or eight putrid carcases were removed from it, as well as a good deal of rat-rubbish.

217. *Group L. (Central Area).*—Cases 34 and 43, attacked 24th and 27th February, occurred in two bootmakers employed at Siddaway's boot factory, 47, Market-street. These premises were less than 100 yards from Her Majesty's Theatre; it was not noted whether the two patients worked in the same part of this large establishment. The first of them lived about a mile away in a house which was free from all signs of infestation, and in a neighbourhood which yielded no indigenous cases; the second in a suburb several miles away which has at no time harboured any other case of plague, and in a house which was clean, in perfectly good order, and free from all signs of infestation. The first patient said that eight dead rats had been found and removed during a few days prior to his attack, and on cleansing the factory abundant traces of present infestation were found, and many carcases were removed from it.

218. *Group M. (North-central Area).*—This consists of five cases which occurred in men employed at Andrew's printing-house, 13, Bridge-street. All of them lived at houses which were ascertained to be rat-free; three of them in neighbourhoods at distances of from 1 to 3 miles, two of them in suburbs reached only by train at distances of 7 or 8 miles. The two latter had never harboured any case of plague, and no reason had appeared for suspecting that two of the former three were at any time infected. But the printing-house was riddled with rat-holes from basement to the top story; a history of dead rats found shortly before, and of the capture in traps of large numbers of live rats, was given by the workmen; eighteen carcases were removed by the disinfecting staff, and from between floors and ceilings, behind matched-board linings, and from other such places, no less than thirty-five loads of rat's dung, rat's nests, and general rat-rubbish were removed.

219. These and one other were the only premises in connection with which cases of plague occurred on the North-Central area, and it is convenient to refer here to Case 129, attacked 15th May, that is to say, two months later than any of the foregoing. The patient was a packer employed at a very large hardware store, who lived in a railway suburb which had never harboured any case of plague. The store was extremely well built and kept; all basements were of concrete, and all apertures were fitted with wire netting to aid in excluding rats. It had on one side of it a lane, on which Andrew's premises abutted. The latter were in so exceedingly bad a state that they were closed, and were repaired in a very leisurely way in consequence; so that at the date of attack of Case 129 rubbish was still being removed from them by way of the lane, which, of course, gave access to the hardware store as well. Careful inquiry revealed no other source of danger in Case 129; but it is quite possible the patient ran risks elsewhere.

220. *Group N. (Pyrmont Area).*—This consists of two cases which were separated by an interval of nineteen days. One was employed at, the other frequented, Buckle's wharf, at which plague-rats had recently before been taken, namely, on 7th, 8th, and 10th April, and from a wharf close by on 12th April; previously Case 78 had been attacked on 24th March, having been employed at a timber wharf next to Buckle's, where dead rats had been found in number. These were Cases 99 and 123. The latter patient, who had inhabited rat-free premises in an uninfected neighbourhood for thirteen days before his attack on 6th May, frequented this wharf for the greater part of a week before going by sea to the north of the State; he fell ill the third day after leaving. The little steamer in which he travelled had not only been fumigated and freed from rats before her departure, but was also on her first voyage; only two or three rats had been found on her. The wharf was in fair condition, but large quantities of produce as well as live pigs were landed there, and pig-yards and some stables were ill-constructed and dirty.

221. The last of these four groups, though probably entitled to its place in the list, is not as convincing as the other three, which, on the whole, furnish evidence of connection between plague-infection and premises, and between infective premises and presence of diseased rats, as good as can be desired. All the sufferers

were united by one common circumstance, and by one only, namely, resort to the same rat-infested premises; in each group all were taken ill within three days of each other; none lived in infected neighbourhoods; and although it is true that all of them were free to visit infected neighbourhoods, yet the attack of all at about the same date excludes that explanation of their infection; lastly, no secondary case occurred at any of their places of residence, as distinguished from the adjudged places of their infection. So that while it is quite impossible, on the one hand, to surmise how it happened that the components of the three groups respectively came to be attacked at the same time, unless reference be made to the places of business to which they resorted; on the other the infection of plague is clearly enough shown to have existed in those places by the discovery of the carcases of dead rats in unusual number, and at a similar stage of putrefaction, at a time at which plague is known to have been epizoötic among the rats of the several neighbourhoods.

222. In connection with this short series (which corresponds with the series of 17 similar instances given in the Report, 1900, p. 35, Table XIII, but in much less detail) Case 14, Paddington area, should be recollected; in which the patient, who lived at a distance, fell ill rather less than three days after having cleared away rat-rubbish and two putrid carcases from beneath the floor of the house at which Case 13 had occurred.

Part III—The Epizoötic in relation to the Epidemic.

INTRODUCTORY.

223. IN all accounts of epidemic plague which have hitherto been published, the following causes have been recognised as efficient: (a) communication of the infection from the sick by direct and (b) by indirect means; (c) place-infection. By the two former the infection would be diffused, by the latter maintained.

The term "place-infection" is employed below in the sense in which it is used in India; this has has been mentioned above, (par. 36).

It seems to be now very generally admitted that communication of the infection from the sick occurs so rarely in the bubonic and septicæmic forms of the disease, that it might well be neglected in speaking of epidemic plague. But the singular lapse (pointed out by Hankin nearly five years ago) by which sufferers are regarded as no source of danger to others while they stay at home or at a near hospital, and yet are commonly regarded as the conveyors of the infection to clean places if only they travel away from home, seems (from the report of the Plague Commission in India; see also the footnote at page 37) to be still unrepaired. Nothing further is needed to show that the aetiology of plague is still a matter of doubt with a large majority.

224. These causes would amply suffice, of course, to explain the epidemicity of plague; and thus far the share which may be borne therein by rat-plague has been left in a position of undefined importance.

225. To refer to well-known reports on plague by English writers for example, the "History of the Progress of Plague in the Bombay Presidency from September 1896, to June 1899," although it contained very full references to Mr Snow's observations on migrations of rats and coincident spread of the epidemic in the same directions, nowhere suggested that the rat was the sole important cause of epidemic plague, and at the same time did rely on the other causes of spread which have been mentioned above. Secondly, the Report of the Indian Plague Commission, dated July 1901, merely admitted that sometimes rats might spread plague, and throughout represented direct or indirect communication of the infection from the sick and place-infection, as the prime causes of epidemic plague. Lastly, the Medical Officer to the Local Government Board, in his preface to Reports and Papers on Bubonic plague by Dr. Bruce Low, dated July 1902, discussed this relationship to which, he said, Dr. Bruce Low had given particular attention, and after consideration of the world-record submitted to him concluded that although it went "to confirm

" belief that, as regards plague, man and the rat are reciprocally infective, fail " completely in affording sufficient data for determining the degree to which man is " in danger through the rat."*

226. The difficulty of perceiving how the infection could be often conveyed from rat to man weighs heavily with some, no doubt, against the probability that epizoötic plague stands in causative relation to epidemic plague; yet at a very early date the practical efficiency of the rat in disseminating this infection oversea was generally asserted and admitted.

227. Nevertheless, Hankin had reviewed† certain epidemiological data in 1898, which had been gathered at Bombay, and had inferred that the incidence of plague on neighbourhoods and on houses stood in relation to their accessibility to rats, and not to any other of the several factors then and still commonly relied upon as secondary causes, such as filth, overcrowding, &c. &c.; and he had at the same time intimated his opinion that some intermediary insect was necessary to communicate the infection from rat to man. In the same year Simond,‡ after reviewing epidemiological data concerning the mode of spread of plague gathered in India, expressed his opinion that its epidemicity was due to migrations of plague-rats and not to human intercourse; at the same time he named the flea (and the bed-bug; but with the latter he was unable to experiment, and he assigned little importance to it *a priori*, having been apparently unaware that these insects are found in great numbers on rats, at all events in some parts of the world) as the intermediary insect which he, as well as Hankin, conceived to be necessary. Simond's hypothesis of the flea has indeed attracted very general attention, and perhaps there is now hardly anyone who is not aware of it, although in reality it was a secondary part of his paper. These contributions by Hankin and by Simond appear to me to be the only *epidemiological* contributions which have thrown much light on the aetiology of plague; and their weight lies, not in any theory as to the manner in which the infection is communicated from rat to man, but in exclusion, so far as their observations went, of infection derived from man as an efficient cause of epidemic plague. But this was overlooked, and the aetiology of epidemic plague remained obscure and, indeed, in confusion.

228. This result has followed in part—but, as the papers by Hankin and Simond have shown, in part only—from plague having occurred most often in eastern and other semi-civilised communities where accurate epidemiological observations hardly can be made. Hence the outbreak at Sydney in 1900 afforded a good opportunity of learning something exact of the mode in which plague spreads, from its having happened among a wholly civilised, white population, which lived under the same conditions of clothing and housing, of food, customs, social organisation, and local government, as are found in the cities of Europe. The Department was prepared to take advantage of it (see Report of the Board of Health on the case of A. P., Sydney, 7th February, 1900; or, Report 1900, Appendix L., in which the more important parts of that document were reprinted). Before occurrence of the first case (that of A. P.) inferences had been drawn from the reports so far published of the epidemics which had occurred or which were in progress in other parts of the world which differed in important respects from the opinions expressed by the historians themselves. By those inferences the action of the Board was guided, as has already been mentioned. And when the observations made and recorded during that outbreak came to be reviewed, it appeared that epidemic plague at Sydney had not been caused in any degree either by personal transmission of the infection, or by dissemination of fomites; and while it was rendered quite clear that place-infection could have played but an insignificant part at most in maintaining the infection, it seemed most probable that it had in reality played no part at all.

The only parts of the world, as far as I have seen, in which our observations of 1900 have been repeated by others, are Brisbane in Queensland, and Port Elizabeth in Cape Colony; at both of these places they seem to have been practically confirmed. At Brisbane, Dr. Halford§ during the epidemics of 1901 and 1902, and at Port Elizabeth, Dr. Blackburne|| during the earlier half of 1901, were both able to

exclude

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* I much regret to find myself compelled to point out here that the account of plague in New South Wales which is given in the volume referred to (and of which I am in the best position to speak authoritatively) is erroneous in almost every detail of importance.

† Annales de l'Institut Pasteur, 1898.

‡ *Uib cit. sup.*

§ Report on 117 case of plague occurring in Brisbane in Sporadic Form; by the Medical Officer to the Metropolitan Joint Board, Brisbane, Q., 1902.

|| Lancet, 11th October, 1902.

exclude diffusion of the infection by man, and to trace association between cases of plague and plague-rats as clearly as could be reasonably expected. Both, however, committed themselves to statements concerning the connecting link between rat and man which, it is most important to note, had not been at that date sufficiently supported by direct evidence, as I have myself elsewhere pointed out.*

229. These results constituted a step of which the importance has hardly been appreciated (W. Kolle alone, as far as I know, has perceived their bearing and weight: see Bericht über die Thätigkeit in der zu Studien über Pest eingerichteten Station des Instituts für Infectionskrankheiten, 1899–1900, Zeit. f. Hyg., 1901, p. 397). If under conditions which admitted of accurate observation the generally accepted causes of epidemic plague were seen not to have been in operation, some other cause was to be sought. For what had been thus pointed out was not merely the result of interference with the natural course of the disease by good management—such, for instance, as is implied in prompt removal of patients to hospital, and in prompt disinfection of their dwellings; nor could it be ascribed to generally favourable conditions of housing, feeding, work, and climate. Although it might fairly be argued that the comparative smallness of the total number of cases was due to those factors, yet the cause of the absolutely large number (303) which did occur still remained to be discovered. It was certain that the infection had not been diffused and maintained by man; how then had it been spread? Place-infection having been excluded by the facts, but one other means presented itself, and, in my opinion, but one other could be reasonably surmised. This was the rat, in whose body, and in whose body alone out of all places external to man's body, the infection had been shown to be commonly present.

230. If man commonly received the infection from the rat—if epizoötic plague were indeed the cause of epidemic plague at Sydney; then coincidence between plague-rats and plague in man on the same premises should be demonstrable, and (it seemed, *a priori*), easily demonstrable. But in the course of the review referred to we found that we had not demonstrated it. Dr. Tidswell had, indeed, been enabled to identify but 23 plague-rats throughout the epidemic, and none of them were obtained from premises which had yielded cases of plague in man. Or, if findings of putrid carcases in which the nature of the disease, which, evidently, had been the cause of death, could not be rigidly identified, be accepted as evidence of epizoötic plague (as under all the circumstances it reasonably may), then dead rats in number were only observed on about 70 premises, although 221 premises were the adjudged places of infection for 255 cases. But the reader who has perused the foregoing pages need not be told that, so far, at all events, there is no evidence that this discrepancy was a matter of fact; clearly it may have been apparent only, and may have resulted from the method of observation, which was certainly imperfect.

231. On recurrence of the disease in 1902, then, we were prepared by former experience to examine this relationship more closely, as well as to check the correctness of our earlier observations on the share taken by man, fomites, and place-infection in diffusing and maintaining the disease. It has already been shown that former conclusions regarding these factors have been completely confirmed. Besides this, further continuous observation and reflection have completely failed to suggest any other source of the infection than that furnished by diseased rats.

232. The ground, therefore, seems to be thoroughly cleared. All that remains is to inquire whether during the second epidemic improved methods of observation did or did not reveal such frequent and close association between plague-rats and plague in man as suffices to furnish a strong presumption that diffusion of plague-rats was the sole cause of the epidemic.

233. From the method of description selected, the reader is now in a position to judge in how far the connection referred to has been discovered, and in how far it deserves to be recognised as the essential condition which we are convinced it was. Here it is necessary only to mention a few numerical statements, to refer briefly to the more cogent facts already related, to trace the course of the epizoötic, and to advert to the conditions of observation in the field which—and which alone, I think—have caused the results, although improved upon those attained in 1900, still to remain defective.

Time

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* Public Health, Vol. XIV, pp. 340–1.

TIME AND PLACE RELATIONS.

234. In the first place, the following table, which necessarily begins with the epidemic of 1900, exhibits a certain general relationship in time between epizoötic and epidemic:—

TABLE XXIV.—Showing month by month the number of plague cases which occurred, and the number of plague-rats which were identified, during the epidemics of 1900 and of 1902, together with the interval which elapsed between the two; as well as a part of the plague-free time which followed on conclusion of the second outbreak.

Year.	Month.	No. of Persons infected.	No. of plague-rats identified.	Period.
1900...	January	1	......	First epidemic.
	February	3	9	
	March	51	2	
	April	107	6	
	May	93	5	
	June	41	1	
	July	6	......	
	August	1	......	
	September	......	......	
	October	......	......	
	November	......	......	
	December	......	......	
1901...	January	......	......	
	February	......	......	
	March	......	......	
	April	......	......	
	May	......	......	
	June	......	......	
	July	......	......	
	August	......	......	
	September	......	......	
	October	......	......	
	November	1	4	Second epidemic.
	December	1	......	
1902...	January	6	5	
	February	26	25	
	March	57	6	
	April	20	37	
	May	22	23	
	June	6	4	
	July	......	1	
	August	......	......	
	September	......	......	
	October	......	......	
	November	......	......	
	December	......	......	
1900-2 Totals...		442	128	

235. In 1900 only 187 rats, selected from a recorded take between 18th April and 31st October, 1900, of 108,308, were examined in the laboratories. During the first interval (September, 1900, to November, 1901) only 237 were examined. From 16th November, 1901, to 31st March, 1902, the recorded number of rats taken by the Departmental staff and by the public (who again received a capitation allowance of 3d.) was 47,285, from which 1,730 were selected by the Departmental staff in accordance with the rough rules already mentioned (see par. 81), and were examined in the laboratories; 40 of them were found to be infected. From 1st April onwards all rats taken by the Departmental rat-staff were delivered at the laboratories, and were examined; the number from 1st April to 14th July, when the last plague-rat was identified, was 28,618, and 65 were found infected. From July 13th to December 31, rats collected from the wharf line within the city, from the city proper, and from adjacent municipalities, to the number of 25,664 were collected, and 12,051, being all that were taken by the Departmental staff, were examined in the laboratories; none of them were infected. From 1st January to 31st March, 1903, rats to the number of 4,254 were collected from the wharf line within the city, and from closely adjacent streets of the city only, and 3,952 were examined in the laboratories; none of them were infected. That is the evidence of general coincidence in time between occurrence of plague in man and finding of plague-rats.

236. It is also the evidence that at Sydney it did not appear that plague in a chronic form persisted among the rats after the apparent epizoötic had ceased.

237.

237. Secondly, the table below shows a general coincidence in place between occurrence of cases and findings of plague-rats.

TABLE XXV.—Showing the *indigenous* cases of plague which occurred in each of the 8 wards of the City of Sydney and in forty metropolitan municipalities, the number of rats collected in each district, and the number of plague-rats identified in each collection :—

	First Epidemic. 19th January, 1900—9th August, 1900.			Second Epidemic. 4th November, 1901—8th June, 1902.		
	Cases.	Rats.		Cases.	Rats.	
		No. Examined.	No. Infected.		No. Examined.	No. Infected.
CITY OF SYDNEY.*						
Bourke Ward	24	21	2	8	558	5
Brisbane ,, ...	56	28	13	12	1,759	17
Cook ,, ...	14	14	1	3	1,258	19
Denison ,, ...	31	14	......	14	2,454	14
Fitzroy ,, ...	2	4	......	2	1,080	2
Gipps ,, ...	16	9	......	3	773	4
Macquarie ,, ...	22	4	1	28	600	13
Phillip ,, ...	14	1	1	12	261	4
SUBURBAN MUNICIPALITIES.						
Annandale	4	1	......	......	2	......
Alexandria	......	......	......	8	317	4
Ashfield	......	......	......	......	......	......
Balmain	......	......	......	......	565	......
Bexley	......	......	......	......	......	......
Botany	......	......	......	......	150	......
Botany North	......	......	......	......	48	......
Burwood	......	1	......	......	2	......
Camperdown	2	......	......	2	332	5
Canterbury	......	......	......	......	......	......
Concord	......	......	......	......	......	......
Darlington	......	1	......	......	233	......
Drummoyne	......	......	......	......	3	......
Enfield	......	......	......	......	......	......
Erskineville	......	......	......	......	66	......
Glebe	6	......	......	......	285	......
Hunter's Hill	......	......	......	......	11	......
Hurstville	......	1	......	......	......	......
Kogarah	......	......	......	......	2	......
Lane Cove	......	......	......	......	3	......
Leichhardt	1	1	......	......	......	......
Manly...	9	48	3	......	28	......
Marrickville	......	......	......	......	15	......
Marsfield	......	......	......	......	......	......
Mosman	......	......	......	......	7	......
Newtown	......	1	......	1	346	12
North Sydney	......	3	......	......	144	......
Paddington	20	5	......	9	1,120	3
Petersham	......	......	......	......	1	......
Randwick	......	1	......	......	17	......
Redfern	25	2	2	1	946	1
Rockdale	......	......	......	......	5	......
Ryde	......	......	......	......	......	......
St. Peters	......	......	......	......	15	......
Strathfield	......	......	......	......	......	......
Vaucluse	......	......	......	......	1	......
Waterloo	10	......	......	10	687	2
Waverley	3	3	......	......	90	......
Willoughby	......	......	......	......	29	......
Woollahra	5	15	......	......	45	......
TOTAL	264	178	23	113	14,258	105†

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* At the end of 1900 the city was divided into 12 wards. The earlier arrangement has been retained in this Table for purposes of comparison.

† Found on 40 inhabited houses (dwellings or places of employment), at 13 wharves, and in 6 streets, lanes, &c. ; or at 59 different places in all.

238.

238. From some part of each of the 8 wards into which the city proper is divided (total area 2,880 acres, number of houses 21,137), all of which yielded cases, and from some part of each of those 6 of the 40 municipalities comprised in the metropolitan district which yielded cases of plague, plague-rats were collected. No plague-rats were got from districts in which no indigenous cases occurred. Neither were any got from districts into which cases had been merely imported; the extent to which the search was carried in such districts is shown in the sixth column of the preceding Table.

239. With assistance of the details already given (see Mode of Spread, p. 18), the general indication afforded by this table can be supported a little more directly. Thus, although Alexandria and Waterloo have a combined area of 1,830 acres, which carries 3,947 houses, the findings of plague-rats were confined exactly to those neighbourhoods in which the cases of plague were found; or, although Paddington has an area of 403 acres, which carries 4,386 houses, plague-rats were found only on that very small part (of about 16 acres, carrying 163 houses) which has been named the Paddington area, where the 9 (or 11) cases which constituted that sub-epidemic were found. Again, Camperdown covers 435 acres, and carries 1,503 houses, but plague-rats were identified only at premises in that street where the two indigenous cases of plague were met with. So also at Newtown, where the municipality covers 442 acres, and contains 4,521 houses, the only case of plague which happened there was found within half a dozen doors of the butcher's where a local manifestation of the epizoötic occurred, and at the same date. There is good evidence, then, of close association in place between plague cases and plague-rats.

240. Yet some evidence is required of closer association between cases and plague-rats; that is to say, of an association demonstrable in a preponderating proportion of individual cases. But the fact as regards such association is that whereas 113 cases have been adjudged to have been infected on 86 separate premises, and although plague-rats were identified on 40 inhabited premises (be they dwellings or places of employment), plague-rats and cases coincided but 4 times. Or, should that way of judging the facts be thought too rigid (as I have no doubt it is), then it can be stated that cases and the removal by the disinfecting staff of dead rats from the premises which were the adjudged places of their infection coincided only 47 times. This is a considerable proportion, though not large enough to be quite satisfactory; yet, although it may not be expanded, a much fuller statement of certain facts should be added to it, and considered in connection with it.

NOTES ON GENERAL EXPERIENCE WITH THE EPIZOÖTIC.

241. Experience has led us to regard the finding of several carcases at about the same stage of putrefaction on any premises, as evidence that disease has been at work (poison having been excluded). Further we recognise as evidence of death by disease not merely the carcases themselves, but the fact that they were found; for though rats die in the ordinary course from day to day their bodies are rarely discovered, and are even rarely a cause of nuisance. It has to be borne in mind, therefore, that the above-mentioned proportion of plague-houses from which dead rats were removed is ruled by the requirement that in order to form acceptable evidence of disease several carcases must be found; but for this precaution the proportion of such premises to indigenous cases would stand higher. Secondly, the evidence of infestation of premises consisted in rat-holes, rat-runs, and rat-rubbish (paper, bones, rags, straw, &c.) accumulated between floors and ceilings, between double partitions, and in other such places; while evidence as to recency of the infestation was furnished by the state as to moistness of the rats'-dung discovered, as well as by the actual finding of rats or of comparatively fresh carcases. Then, there was strong evidence of infestation in the case of 61 places of residence, of 23 places of employment, and of both in 3 others; that is to say, all these patients either lived or worked, or both lived and worked, in close association with rats, while in the case of 47 adjudged places of infection it was plain that the rats had lately been killed by disease. That disease was identified with plague on premises which yielded

plague-cases 4 times only; the carcases having been in all other instances too far advanced in putrefaction for that rigid bacteriological examination which alone, I consider, warrants use of the word "identified."

242. Here it should be additionally noted on the one hand that a minority of total premises are rat-infested, and on the other that the presence on inhabited premises of plague-rats is far from being necessarily accompanied by cases in man. For instance, no cases occurred in connection with 36 of the 40 inhabited premises mentioned above on which plague-rats were identified; and Jones' store (par. 84) affords a striking example of this. But I have already pointed out that after examination of all the available facts it appeared that mere association with plague-rats does not suffice, apparently, to infect, and that "something further, and something not commonly existent, seems necessary to enable communication of the infection from the source to man . . ." (Report, 1900, p. 36). Our more recent, and more fully recorded, experience likewise obliges us to suppose that infection with plague is the result of a chain of circumstances which, on any individual premises, is seldom complete in all its links.

243. If epizoötic plague stand in causative relation to epidemic plague it must precede the latter. It is probable that this was the case in 1900, but we did not actually ascertain it. Probably it was the case in 1902, but, again, it was not actually ascertained. The bare facts are that Case 1 was attacked on 4th November; that a rat search began on 16th November; and that a plague rat was taken at one of a line of wharves, at which produce was habitually landed, on 18th November: while the case occurred in connection with a produce store at which presence of a fatal epizoötic among the rats which infested it was observed on 14th November, which epizoötic was proved to be plague. Yet it is hardly possible to mistake the meaning of this chain of events, although they do not constitute a proof. The patient certainly did not infect the rats at the store, for he was suddenly taken ill shortly after reaching it for work as usual, and immediately went home again. It is quite clear, however, that plague among the local rats preceded the occurrence of cases on the Paddington area; on the Alexandria area it must have done so, because, on examination of the patient's store within 48 hours of his attack, only putrid carcases in considerable numbers were found; some other and similar instances have been already mentioned above. Again, it was ascertained to have preceded attack of all cases together (except the first, which very strictly speaking must be excepted for want of demonstrative proof) and by five weeks or thereabouts.

244. It is now necessary to remind the reader that all these gaps in the evidence are not defects in fact, but evidently are due in a large measure—I think they are entirely due—to those practical difficulties which have already been mentioned (see pars. 114–5–6). It was said above that it had appeared, *a priori*, that coincidence on premises of the disease in rats and in man should be easily demonstrable. That such a coincidence did occur very often I do not doubt; but, after making prolonged attempts to follow the course of the epizoötic by methods which were modified from time to time, I am able to assert that this business is an exceedingly difficult one in any city. Briefly, the only methods of search thus far appearing to be practically available ensure, almost exclusively, the capture of healthy rats. The reasons have been sufficiently explained above. We must resort, then, to the teaching of those instances in which multiple cases occurred either at places of residence or at places of employment. Similar instances constituted the most weighty part of the Report on the Epidemic of 1900, in relation to the point under consideration; but those now referred to, having been much more minutely recorded, speak, I think, unmistakably. I do not hesitate to say that the case of the Criterion Hotel, Central area, alone would warrant a confident assertion that the doubts and hiatuses which the record of the epidemic in general and on particular areas shows, must be the result solely of inacquaintance with all the circumstances. This, however, must be left to the reader's judgment, to which it is submitted without hesitation.

245. I conclude this section with a record of some general observations on the course of the epizoötic. Transport of the disease *per saltum* has already been noted. From the centres of infection thus established it spread, as observed in 1900,

by continuity; and, since it can be thus transported, it follows that any district which has become infected thus or otherwise may be reinfected, or infected in another part of it, by the same means at some later date; and it may be thus reinfected not merely from the local *fons et origo* (which we consider was in both of our epidemics that particular line of wharves on the eastern shore of Darling Harbour, which—again, we consider—was on both occasions infected from places oversea), but also from any other infected district with which it is in the requisite kind of communication. The requisite kind of communication, or that which is most favourable to transport of the infection, appears, as a matter of observation, to be the distribution of fodder.

246. Plague is commonly represented as spreading among the rats of a district with extreme rapidity, and as exterminating them almost. Contrary to reported experiences in many other countries, sick rats have not been often seen in the open at Sydney. The instances cited by more or less trustworthy witnesses were not more than four during 1902, and with one exception it was said that only one sick rat at a time had been seen. Figures which have been given already show that the finding of plague-rats by the ratcatchers (particular premises being excepted, and reference made merely to buildings and their curtilages which were examined in the ordinary course of the night's work on infected areas) was not common. On certain badly-infested premises the disease has been seen to rage, and to exterminate the horde apparently—at Exton's, and Huxley's, and Goff's stores, for instance. In those cases the epizoötic was apparently over as regards those houses before the examination began. In another instance—at Jones's store—it seems that early information enabled the examination to be begun before the outbreak had long existed. Not merely were live rats found in number; but carcases were fresh, and there was no difficulty at all in identifying the disease. Rats usually retire from places where the horde has met with misfortune; but from this it would seem that they do not always do so quite so promptly as has been supposed. But such findings of carcases in great numbers were few, and were entirely confined to badly-infested, confined premises; while the carcases picked up in streets and lanes were almost always putrid, and beyond reasonable doubt had been thrown out from premises on which they had died. Here, then, we have seen the epizoötic rage with exterminating violence; but the case of the "Antillian" goes to show that very close quarters (or some other circumstance, possibly of quite another kind) are necessary. The outbreak among the comparatively few rats which that vessel carried—probably not more than 100 originally—appeared to be still in course of making slow progress when it was detected.

247. Then, again, we have no evidence of rapid spread over neighbourhoods. Cases of plague, of course, most certainly draw attention to the state of the local rats, and plague among the latter is (we think) attended by cases in man only in a small minority of instances; so that it is probable that a larger proportion of rats was affected than we have actual evidence of.

248. On the whole, the following opinion may be ventured:—The disease is much more frequently communicated from rat to rat than it is from rat to man, or from man to man (which latter is so uncommon as to be negligible, if primary plague pneumonia be excepted); and as the disease in the rat is a septicæmia, it can hardly be much more easily communicable between rat and rat by mere contact than it is between man and man, of which, also, laboratory experience affords direct evidence (see Further Observations on the Mode of Infection, p. 65). Hence I suspect that, as in the case of man, some special circumstance is requisite. I do not know what this is; but Dr. Tidswell has been struck in this connection with the fact that during the epizoötic fleas were abundant on all the rats brought to the laboratory, while as soon as evidence of its continuance had failed, fleas became so uncommon on the rats, which were still brought in in large numbers, as to be quite insufficient for purposes of the laboratory collection (see Ecto-parasites of the Rat, p. 71). The abundance of fleas on rats during continuance of the epizoötic was not specially associated with illness of the animals; it was generally observed, and on those which were perfectly healthy as well as on others.

SPECIES OF RATS AFFECTED.

249. As to the species of rats affected, Dr. Tidswell has made the following note:—

> With the exception of a single specimen of the Australian water-rat (*Hydromys*), which was found to be perfectly healthy, all the rats received belonged to one of two species—*Mus decumanus* and *Mus rattus*. No record was kept of the actual numbers of each. In the whole collection there were about as many of one as of the other; but *Mus rattus* predominated among those taken along the shores, and *Mus decumanus* among those taken inland. The infected specimens were all *Mus decumanus*. The rats taken from the "Antillian" were all of this species. I have not found plague in *Mus rattus*, although this species was readily infected in the laboratory.*

MODE OF INFECTION.

250. After association between plague-rats and cases in man has been demonstrated sufficiently often to furnish a strong presumption that the epizoötic might have stood in causative relation to the epidemic; and after this presumption has been strengthened by the observation that whenever there was reason to believe that the important facts were fully known the epizoötic preceded the occurrence of cases in man, a difficult problem presents itself. This is, how the infection can be communicated from rat to man; and, after that has been shown, how it can be so communicated sufficiently often to give rise to an epidemic. The mode of infection in plague is discussed by Dr. Tidswell in the following paragraphs:—

"*Further Observations on the Mode of Infection*," *by Frank Tidswell, M.B., M.Ch., D.P.H., Micro-Biologist to the Board of Health.*

251. The subject of the mode of infection was previously discussed (Report, 1900, Appendix A) under the sub-headings of (*a*) inoculation, (*b*) ingestion, and (*c*) inhalation. It was shown that experimental animals such as rats and guinea-pigs had invariably succumbed to subcutaneous inoculation; and that they sometimes became infected by feeding; whilst the few experiments concerning inhalation had given negative results. Except in the matter of inhalation with which some other investigators have reported successful results, and upon which our own observations are too few to afford valid data, the issue of these experiments was in general accord with similar experiments made elsewhere. Further, they have their counterpart in epidemiological observations. For according to current belief the acquisition of plague by ingestion, if it occur at all, is not epidemiologically operative, whilst inhalation is held to afford the mode of entry only in the pneumonic form of the disease. On the other hand, the outcome of our local experience is in keeping with the general tenor of available reports in ascribing the overwhelming majority of attacks to inoculation of the bacillus of plague through some part of the external surface of the body. Accordingly the questions of infection by inhalation or ingestion have been left in abeyance, and the laboratory observations since made have been directed towards the elucidation of the manner in which the micro-organisms of plague effect their passage through the skin.

(*a*.) *Infection through slight skin lesions.*

252. In the former report it was mentioned that some of our patients showed wounds or abrasions of some part of the skin within the lymph-collecting area of the bubo; but that in all instances in which material from such lesions was examined no plague bacilli were detected in it. On the other hand, attention was directed to facts which showed that plague could be acquired through small wounds of the skin, *e.g.*, the cases of certain medical men in India and China who became infected through wounds incurred whilst making autopsies of plague cadavers. It was reported, by way of experimental support in this matter, that the test animals used in this laboratory had always died after subcutaneous inoculation of cultures or plague infected material, and an instance was given in which death followed so small a lesion as a prick with an infected needle. It may be added that culture material applied to a lightly scarified area of a guinea-pig's skin has been found to be followed by infection.

253. More recently information has come to hand of the observations of Weichselbaum, Albrecht, and Ghon, confirmed by Kolle (Zeitschrift für Hygiene, XXXVI, p. 397), that guinea-pigs succumb to plague after the application of culture material to a shaved area on the abdominal skin. Repetition of this experiment was successful in the three instances in which it was tried in this laboratory, but only on condition that the culture material was applied immediately after shaving. In four other instances, when the animals were allowed to remain twenty-four hours (3) and seventy-two hours (1) after shaving before the application of the culture material, the animals all remained unaffected. The first three animals serve as controls to the last four as regards virulence, for they were inoculated from the same cultures at the same times. Five similar experiments were performed by application of the material to the shaven thigh of guinea-pigs. In three, the application was made immediately after shaving; one died on the fifth day from plague; the other two remained unaffected. In another animal the application was made in twenty-four hours and the animal died on the fourth day; no plague bacilli were found in the tissues and the isolation of *staphylococcus pyogenus aureus* and *staphylococcus pyogenus albus* from the blood, liver, and spleen showed that death was due to ordinary septicæmia. The remaining guinea-pig of this series underwent the application seventy-two hours after shaving and remained unaffected by it. In a third series of animals the application was made to a shaved spot on the head. Of two of them to which the application was made immediately after shaving, one died, the other remained unaffected. Two others

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* But, since this was written, naturally-infected specimens of *Mus Rattus* have been found on one premises only.

receiving the application in twenty-four and seventy-two hours respectively after shaving, remained unaffected. The total result of these experiments was that five animals succumbed to the plague; three after application of the material to the abdominal area, and one each after its application to the thigh and head respectively. In all cases these animals received the application immediately after shaving. In the remaining cases where an interval of twenty-four hours or more elapsed between shaving and the application of culture the animals did not die of plague. In all the fatal cases there was evidence of local re-action in the formation of tiny vesicles (*phlyctenules*) upon the infected shaved areas. The essential details of the experiments are given in the following table:—

TABLE XXVI.—Showing the results of application of culture of *bacillus pestis bubonicæ* to shaved areas of guinea-pigs.

No.	Part shaved.	Time culture applied after shaving.	Result.	Remarks.
1	Abdomen	Immediately	Died 3rd day...	Phlyctenule 2nd day; inguinal bubo; P. bacilli in tissues.
2	,, ...	,, ...	,, 8th ,, ...	,, ,, ,,
3	,, ...	,, ...	,, 3rd ,, ...	,, ,, ,,
4	,, ...	24 hours ...	Unaffected.	
5	,, ...	24 ,, ..	,,	
6	,, ...	24 ,, ...	,,	
7	,, ...	72 ,, ...	,,	
8	Thigh ...	Immediately	,,	
9	,, ...	,, .	Died 5th day...	Phlyctenule 3rd day; inguinal bubo; P. bacilli in tissues.
10	,, ...	,, ...	Unaffected.	
11	,, ...	24 hours ...	Died 4th day...	No phlyctenule; no bubo; pyogenic cocci in tissues.
12	,, ...	72 ,, ...	Unaffected.	
13	Head ...	Immediately	Died 10th day..	Phlyctenule 3rd day; cervical bubo; P. bacilli in tissues.
14	,, ...	,, ...	Unaffected.	
15	,, ...	24 hours ..	,,	
16	,, ...	72 ,, ...	,,	
17	Abdomen	Control ...	Died 5th day...	Subcutaneous injection; inguinal bubo; P. bacilli in tissues.

254. The shaving of the guinea-pigs was performed in the ordinary way after lathering with soap; the shaved area being afterwards washed clean with sterilised water. Antiseptics were not used in view of their presence vitiating the results. One's personal experience of the smarting occasioned by the application of cosmetics (*e.g.*, Bay rum) to the recently-shaven chin and the associated suggestion of denuded epithelium led to the shaved areas of the guinea-pigs being carefully examined with the aid of a hand lens for evidence of minute lesions. No animal showing actual small cuts or oozing points was used in the above experiments. But short of actual penetration of the skin there were usually to be seen small red points—capillaries showing through the partially-removed epithelium—and the whole area presented the appearance of superficial denudation of epithelium. The material on the razor contained an abundance of epithelial cells, and no doubt, from a histological point of view, the amount of epithelium removed would be pretty considerable. It is to be concluded that the shaved skin is not intact: it is rather the site of a mild abrasion. From the results presented above—the lethality of immediate and innocuousness of later applications—it appears that even this slight abrasion causes enough impairment of the protective function of the epidermis to permit, when recent, the passage of bacteria to the deeper tissues, but that in the course of twenty-four hours the injury is sufficiently repaired for such invasion to be successfully resisted. Physiological considerations no less than actual experience suggest that the passage of plague bacilli through the skin is conditioned by the presence of a lesion of the epidermis at least, but the foregoing observations indicate that the necessary lesion may be very minute.

255. Presuming that minute or gross lesions, such as would suffice for the entrance of plague bacilli, are commonly present upon the human skin, there still remains, as an essential factor for infection, the contamination of the lesion by plague bacilli. In exceptional instances the contamination results from actual contact with infected persons or rats, but in the great majority of cases neither of these conditions obtain. For the mode of infection under review to be epidemiologically operative, the bacilli must be capable of extracorporal existence upon such materials as might gain access to the lesion.

(*b*) *Viability of bacillus pestis upon inanimate materials.*

256. The possibility of plague being acquired per medium of soiled articles led to the following observations being made in this laboratory with the object of determining how long the bacilli could survive upon such articles under the climatic conditions met with in this country. The method followed was to infect portions of various materials, remove them from the source of infection, and subsequently ascertain by culture how long the bacilli remained alive in them. The materials were initially sterilised and then infected by soaking them with broth emulsions of agar cultures of bacillus pestis. They were placed upon unglazed porcelain slabs enclosed within double glass dishes. Samples of each were removed at intervals of one or two days and placed in bouillon tubes, then incubated for twenty-four hours, after which subcultivations of the bouillon were made upon agar tubes. The usual bacteriological checks were made of the initial sterility of the articles used and of their subsequent freedom from extraneous contamination, as well as of the identity of the bacteria in the ultimate cultures. Three observations had to be rejected on account of miscarriage of the precautions and contamination at some stage or other, but otherwise no difficulty was experienced in carrying the tedious observations safely through to the end. In view of the fact that many observers have stated that the bacillus is readily killed by drying, the

various experiments were arranged so as to display the results when the materials were dried rapidly, dried naturally, dried slowly, and kept wet. The first was effected by placing the dishes in the incubator, with a layer of cotton-wool between the upper and lower dishes; the materials all appeared to be dry in about twenty-four hours. The second could not be exactly obtained, since the materials had to be kept in the dishes to avoid contamination, and thus their drying was retarded to some extent; but no special measures were taken to keep them moist, and the materials dried in different periods during the course of a week or two. The third process was effected by placing the porcelain slab on slightly-moistened cotton-wool, which kept the glass chamber moist for a time, and delayed the drying of the materials for two or three weeks. In the fourth case the slab was placed on wet cotton-wool, and the materials did not become dry during the period of observation. With the exception of those incubated, the materials were kept at the temperature of the laboratory and exposed to ordinary light. It is to be noted that the materials received with the bacilli a certain amount of organic material (*bouillon*) which could serve them as pabulum, and such as would be present if the articles had been soiled by infected bodily secretions. The conditions were unnaturally favourable to the survival of the bacilli, in that they protected them from competing saprophytic bacteria. The materials chosen for observation comprised dust from the corners of floors and shelves of dwellings, and from the floor of a produce-store; grain and other produce; clothing materials (linen, cotton, flannel, tweed, &c.), and packing materials such as straw, wood-fibre, and saw-dust. The results of the observations are shown in the following table:—

TABLE XXVII.—Showing results of experiments to ascertain the extracorporal viability of bacillus pestis upon specified materials.

No.	Material.	Number of Observations.	Number of days Bacilli survived in Material.			
			Rapidly dried.	Naturally dried.	Slowly dried.	Kept moist.
1	Dust of dwelling—corners and between flooring boards	6	1	3, 4, 11	21	15
2	,, shelves	1	......	......	2	......
3	Dust of produce store—floor	1	......	......	11	......
4	,, street	6	—1	3, 3, 10	15	13
5	Grain—wheat	6	1	3, 4, 4	7	11
6	,, maize	5	1	3, 4	7	9
7	Potato parings	3	......	3, 4	11	......
8	Carrot parings	2	......	4	15	......
9	Peameal	5	1	4, 5	7	11
10	Bran	1	......	......	15	......
11	Flannel (old washed material)	3	......	3, 4	7	......
12	Silk (old washed material)	3	......	3	11	7
13	Muslin (new material)	4	—1	3	21	12
14	Cotton (new material)	5	2	4, 5	15	11
15	Linen (old material)	4	1	3, 4	5	......
16	Jute sacking (old material)	5	2	4, 5	15	10
17	Tweed (old material)	1	......	......	15	......
18	Serge (old material)	2	1	......	......	15
19	Straw	4	—1	1, 4	21	......
20	Wood fibre	5	......	3, 4, 9	5	7
21	Sawdust	5	1	4, 5, 9	15	......

257. The fact that the bacilli died out in periods varying from less than one day to three weeks, may be taken as indicating that their extracorporal existence is a matter of survival rather than of continued viability. For, as already stated, the materials were soaked with nutrient broth, such as would have supplied the bacilli with abundant food under the condition of artificial cultivation. The issue of the different series of observations shows that the bacilli are markedly influenced by drying. In materials rapidly dried the bacilli survived usually not longer than 24 hours, sometimes less, rarely more; and never longer than two days. In materials drying naturally the bacilli survived usually three or four days, in a few instances for nine, ten, or eleven days. In material drying slowly they survived usually for one or two weeks, and exceptionally for three weeks. In all these instances their extinction seemed to be associated with the drying of the material, but the data contained in the last column of the Table indicate that excessive moisture is not greatly favourable to their continued existence. These various results are in accord with those previously reported (Report 1900, p. 55), and generally with those reported by other investigators.

258. The chief interest necessarily attaches to the results of those experiments which most closely simulate natural conditions. In so far as those dealing with naturally and slowly dried materials may be regarded as fulfilling these conditions, they indicate that the bacilli may be expected to survive on inanimate materials for three or four days as a rule, and that they can survive for as long as two or three weeks in diffused daylight, and at the ordinary indoor summer temperature in this city. But it has to be remembered that the experimental conditions are in fact more favourable to the bacilli than strictly natural ones would be, so that the indicated survival is probably in excess of that which would obtain in nature. It is accordingly to be inferred that such materials can only serve as the means of disseminating plague for usually not longer than three or four days, but exceptionally for two or three weeks after becoming contaminated with plague bacilli.

259. It does not seem likely in view of these results that the infection was brought to us with merchandise from oversea, nor that the second epidemic arose by redispersal of infection remaining latent after the first epidemic. But they do not in themselves exclude infected articles from having had some

share in the local dissemination of the disease. The survival of the bacilli is long enough, in dust and clothing for example, to admit of their carriage therein to lesions such as those mentioned in the previous section. However, if such articles played a part here they were not contaminated by plague-stricken persons, for our patients most often had no association whatever, direct or indirect, with the sick. The one suggestive common feature in their histories is their association with plague-stricken rats. Perusal of the accounts of the two epidemics that have occurred in this State shows that plague-rats have pre-eminently figured as the associates of plague in man, and in many localities it was clearly manifest that they were the forerunners of the incidence of the disease upon human beings. Our experience does not permit us to doubt that the rats were the sources of infection for our patients. But actual contact with them was exceptional; most usually the evidence went no further than to reveal the presence of plague-rats in the vicinity of the place where the patient became infected. As the implied intermediary between rats and human beings, suspicion might reasonably be attached to materials contaminated by the rats.

260. But given the lesion of the skin referred to in the previous section, and given contaminated material such as that just described, infection yet depends on the accidental conjunction of the two within a limited period of the time the last mentioned has received its load of bacilli from the rat. For this conjunction to occur with sufficient frequency to produce an epidemic of plague implies that the bacilli are distributed broadcast by the rats. But there is no good evidence that plague-rats do so generally infect their surroundings. On the other hand attention has already been called (Report 1900, p. 55) to the fact that rats, guinea-pigs, and mice were often placed by us in intimate contact with their artificially plague-infected fellows, or in the uncleaned cages and jars in which animals had died of plague, without in any single instance becoming infected. More recently we have exposed guinea-pigs with shaved abdomens in similar jars with the same negative results, even when the jar and its contents were additionally contaminated with culture material quickly fatal to inoculated controls. The escape of these very susceptible animals under conditions so favourable for mediate infection from soiled articles makes it difficult to conceive how the chance transference of the bacilli in this manner can be epidemiologically significant. In view of all the circumstances it would appear that whilst this mode of infection is possible, and may be occasionally operative, available evidence falls far short of indicating, or even suggesting, it to be the usual or regular means by which epidemics of plague are maintained.

261. That is a very lucid description of the circumstances which must obtain in order that the infection of plague may be communicated from the rat to man. There must be a breach of that epithelium whose function it is to defend the body against invasion by micro-organisms; the breach must be recent and (probably) not more than twenty-four hours old; the infection must be deposited by the rat on inanimate articles with which man can come into contact (or, rather, epidemiologically speaking, is likely to come into contact), and it must not, as a rule, be more than three or four days old: and then, when these four conditions have coincided a fifth must concur with them, which is, apposition of the wound and the deposited infection. The chances against the required conjunction are evidently many. Slight defects of the epithelium sufficient for the contemplated purpose are, perhaps, not very uncommon, and rats which traverse articles in use by man at the requisite stage of illness can discharge infection upon them (from the nasal mucous membrane in earlier, with the excreta at later, stages); yet it does not require much consideration to see that in practice the infection can rarely be taken thus. But I have already expressed an opinion that among the conditions necessary to the spread of infection from rat to man there must be some one (at all events) which is rarely present in conjunction with the rest; can failure to bring the minute wound into contact with the small quantity of deposited infection be it? Clearly such failure must happen much more often than not.

TWELVE CASES IN WHICH INFECTION WAS NOT TAKEN, IN ALL PROBABILITY, BY CASUAL CONTACT WITH DEPOSITED INFECTION.

262. The infection of plague is communicated to man by inoculation through the skin in the vast majority of cases. The proof has been well stated in the Report of the Plague Commission in India; it is " . . . . that primary buboes practically always develop in connection with lymphatics which originate in the skin . . . . . " The constant preponderance of "inguinal" or "groin" buboes over others, was also shown in the same paper to stand in relation to the larger area of skin which drains through the lymphatic glands of the groin. Analysis of returns, which represented 5,442 cases of bubonic plague, showed that the ratio in which buboes occurred in the lymphatic glands of the head and neck, the axilla, and the groin respectively, was nearly the same as the ratio which the skin-areas draining through the lymphatics of those regions bear to each other.

263. The proportion in which groin buboes are met with always preponderates over that in which the buboes occur in other regions of the body; this was very early observed among Eastern races who habitually go barefoot. Before long, however, the same preponderance was noticed among Europeans (though in small number) who did not go barefoot; but the hint thus given seems to have been overlooked, and (perhaps, in consequence) assumed infectiveness of ground-surfaces became a prominent feature in writings on the ætiology of plague. But at Sydney, in 1900, we were able to show that in no less than 73 per cent. of the 286 cases in which buboes were exhibited, the latter were found in the groin, although all the patients referred to were white, clothed in European fashion, and invariably shod during the day (Report, 1900, p. 40). The validity of the banal explanation of the preponderance of groin buboes thus seemed to be rendered more than doubtful.

264. But I had pointed out in the same Report, that the infection of plague was received by man, for the most part, within houses; which seems also to have been noticed in India (Plague Commission in India, July, 1901, Report, p. 101). Now, if the infection be usually received by man within houses, the objection raised above to the banal explanation of the preponderance of groin buboes must be revised; for there is a time of day when nearly all people, whites as well as others, go barefoot; namely, when they are going to bed or rising from it. At that time, therefore, infectious material deposited on floors, carpets, &c., by rats (or otherwise) would be more likely to come in contact with the unprotected skin of the feet than with that of any other part of the body. So that, although conjunction between a recent breach of the epithelium and deposited infection in the requisite state of activity cannot often happen, here is the opportunity for it at all events; and plague was not so frequently contracted by our people in either epidemic but that possibly those persons who exhibited groin buboes might have received the infection in that way. Let us try, then, to ascertain what the fact was: Does the record contain any cases in which infection resulting in groin buboes was, probably, not contracted by casual contact with deposited infection of the unprotected skin of the lower extremities? If it turn out that it does, the hypothesis under examination will be very greatly weakened; must, indeed, be discarded as an explanation of epidemic bubonic plague.

265. Among the 139 cases which constituted the epidemic, there were 106 in which buboes occurred in the groin. But it is necessary to speak more exactly. Our present concern must be with primary buboes, since these alone indicate the region of skin through which the virus entered; and, in order to leave no room for possible confusion between primary buboes and secondary glandular swellings, it is desirable to take into account only those cases in which the groin bubo was solitary. Then the expression "groin bubo" is loose. A bubo in one of the oblique set of inguinal glands indicates infection through the skin of the lower part of the trunk. Buboes in one of the vertical set of femoral glands alone indicate infection through the skin of the feet, or of other part of the lower extremity. An examination intended to discover whether there were buboes betokening infection through the skin of the lower extremity must, therefore, be limited to cases which exhibited *solitary* buboes in one or other gland of the *femoral* chain.

266. The total number of such cases was 60, but the majority are not available for the present purpose. Thus the place at which the infection was taken could not be determined in 16 of them; either the inquiries made failed to reveal any clue to it, or else the evidence for infection at home and at work seemed equally cogent. These 16 must be thrown out, therefore, for they (or some of them) may have been infected at their place of residence, where they were admittedly exposed to the risk ascribed to bare feet which is now under investigation. In 25 other cases it was considered that the patient did receive the infection at his place of residence; so that these, too, must be thrown out for the reason just given. In 3 others the place of employment probably was the place of infection, but the details left room for some slight doubt; these are excluded by way of precaution. Three more were Chinese, concerning whom either information of the required kind could not be got at all, or it was untrustworthy. Lastly, one was a woman whose movements could not be traced. So that 48 of the 60 have to be discarded.

There remain 12 patients who had solitary femoral buboes, and who are confidently adjudged to have received the infection away from home (while at work, in all but one case) and therefore while fully clothed.

267. Most of these twelve cases have been already referred to at greater or less length; their serial numbers are therefore given, together with a reference to the paragraphs in which the necessary particulars concerning them may be found: 1 (par. 77), 14 (par. 92), 18 (par. 212), 211 (par. 21), 34 (par. 217), 49 (par. 134), 70 (par. 218), 84, 88, 93, 125, 129 (par. 219). The following are details of the four cases which have not previously been described:—

Case 84.—M., æt. 39, a tailor; attacked, March 26, at midday, while at work; discharged, May 24; place of employment, 267 Pitt-street. From under the floor of the room in which the patient worked as a presser nine carcases were removed; many others were found under the floors of adjacent rooms, as well as large quantities of rats' dung, nests, rags, paper, and seeds (from a florist's). Place of residence, Strathfield, a suburb 7 miles away, which has harboured no other case of plague at any time; the house was in very good order, and entirely free from all traces of rats.

Case 88.—M., æt. 55, carpenter; attacked, March 27, morning; discharged, April 26; place of employment, Union S.S. Co.'s wharf, Darling Harbour, which was one of the infected line. Residence, Leichhardt, a suburb about 3 miles away, which had yielded no indigenous cases; the house was in good order, clean, and entirely free from all traces of infestation.

Case 93.—F., æt. 27, sempstress; attacked, April 3; discharged, May 21; place of employment, an upholsterer's, 137 to 141 Castlereagh-street. There were abundant signs of infestation with rats everywhere, but no carcases were found; dead rats had been seen six weeks earlier when, it was alleged, poison had been laid. Residence, Marrickville, a suburb about 4 miles away, which had at no time harboured any other case; the house was in good order, and entirely free from all traces of infestation.

Case 125.—M., æt. 54, carman; attacked, May 11, midday; died, May 16; place of employment, Gray's stables, Elizabeth-street, Waterloo, which were infested with rats, and from which a plague rat had been taken on April 26; another plague rat was taken at other stables near by on April 21. Residence, 151 Bullanaming-street, in fair order; it was said that no rats had been seen there, and there were no traces of infestation; no indigenous case had occurred anywhere near the house, but the further neighbourhood of it was not free from suspicion.

268. Of these patients 8 inhabited houses in neighbourhoods which were distant or even remote from the infected area, and which were at all times free from suspicion of infection with plague (yielded neither indigenous cases, nor plague-rats); and while, on the one hand, 11 of the residences bore no traces whatever of infestation with rats (the twelfth alone having exhibited some slight signs of infestation), on the other hand the places at which the patients were employed (including one who had merely visited Her Majesty's Theatre) were badly infested, and had yielded dead rats in number in ten instances at least.

269. It is certain that these persons all fell into danger at their place of employment, and apparent that they were not infected at home. At their employment they were fully clothed; their lower extremities were protected by boots, socks, or stockings, and trousers or petticoats, while their hands, arms, necks, faces, and in some cases their chests too, no doubt, were uncovered, exposed, and in no way protected from casual contact with deposited infection: and, therefore, they should, *ex hypothesi*, have exhibited cervical or axillary buboes. In fact, however, they none of them did so. They were all of them inoculated in one or other lower extremity—in that very area of skin which, beyond all doubt, was well protected from casual contact with deposited infection.

270. I am unable to imagine any plausible explanation of the inoculation of these 12 persons in the lower extremity, which does not include some means of communication between them and plague-rats which is complete in itself, endowed with locomotive powers, attracted to man by instinct, and more likely to reach this than any other part of the body. These requirements betoken an insect, and the insect which best meets them appears to me to be the flea.

Only one other mode of common communication of the infection from rat to man can be surmised, namely, soiling of food with infective excretions or secretions. But the conclusion that bubonic plague is taken by inoculation through the skin is generally accepted on definite pathological evidence; while the other generally-accepted opinion that, at most, man has very rarely been infected by feeding, is based on the all but entire absence of similar pathological evidence to the contrary.

271. Simond's results with fleas have not as yet been corroborated in this laboratory; but several unsuccessful attempts have shown that the experiment is a very difficult one to control, rather than that the infection cannot be conveyed by

means of fleas. A good deal of time has been devoted to preliminary or collateral points by Dr. Tidswell, whose results and remarks upon them are embodied in the following report :—

Ecto-parasites of the Rat. By Frank Tidswell, M.B., Ch.M., D.P.H., Micro-Biologist to the Board of Health.

(*c*) *The Ecto-Parasites of Rats.*

272. The failure of available facts to clearly incriminate deposited infection as the source of plague in our patients made it important to investigate another possible intermediary. In the previous report (1900, p. 56), attention was called to Simond's suggestion that the fleas from rats probably played such a part. In connection therewith it was mentioned that the phlyctenules described by Simond as resulting from the bites of plague fleas had been observed in a few cases in which they had been looked for; that plague bacilli had been found in one of them, and had been also obtained from fleas taken from an infected rat (loc. cit. Appendix A, p. 56). During our more recent experience the occurrence of plague bacilli in fleas taken from infected rats has been twice more demonstrated in a similar way, viz., by cultivation and inoculation experiments. This thrice-repeated observation is in accord with the accounts of other investigations elsewhere, and it seems now well established that fleas from plague rats can harbour plague bacilli. Although this is so, it has not yet been adequately demonstrated that the bacilli so harboured can be carried over to other animals to which the affected fleas have access. Simond, indeed, reported successful results, but the similar experiments of Dr. Kolle in Berlin (Zeit. f. Hyg. Bd. 36, s. 412), and those performed in this laboratory (Report, 1900, p. 57) had negative issues. From the experimental point of view, Simond's observation remains hitherto unconfirmed.

273. Objection to the theory has also been made in view of the nature and species of fleas infesting rats. Simond, whilst candidly admitting his inability to pronounce upon the species of the fleas found by him upon rats in India, and to which he attributes the power of transmitting plague, nevertheless distinctly states that the fleas in question did bite human beings on whom they were placed. (Annales de l'Institut Pasteur XII, p. 673.) On the other hand it has been contended that the fleas infesting rats will not bite man. Dr. Nuttall, of Cambridge, points out that the "rat flea"—*Typhlopsylla musculi*—belongs to an entirely different family from the flea of man—*Pulex irritans*—and that there is no evidence that it will use man as a host (Johns Hopkins Hospital Reports, VIII, p. 21; Jl. Trop. Med., V, p. 65), whilst Professor Galli Valerio, of Lausanne, reports similarly with respect to the two species of fleas—*Typhlopsylla musculi* and *Pulex fasciatus*—found by him upon rats in Europe (Cent. f. Bact., XXVII, s. 1; *ibid.*, XXVIII, s. 842; Jl. Trop. Med., V., p. 33). Briefly, it is said on the one hand (Simond) that fleas from rats did bite man, and on the other hand (Galli Valerio), that fleas from rats did not bite man. In view of the simple nature of the fact to be determined, it would appear most likely that the discrepancy is due to the reference being to different species of fleas. For it by no means follows that the rats in India and in Europe are exclusively infested by the same species. Available accounts, indeed, clearly indicate that a species prevalent at a particular place or time may be represented by a different species at another place or time. For instance, Mr. Carl Baker expresses the opinion that *Pulex inaequalis* seems to be the North American representative of *Pulex goniocephalus* of European hares and rabbits (Canadian Entomologist, XXVII, p. 164), and Mr. L. O. Howard reports that the species which commonly overruns houses during damp summers in the Eastern cities of America "is not, as many have supposed, the human flea,—*Pulex irritans*—but the common cosmopolitan flea of the dog and cat"—*Pulex serraticeps*—(Bulletin No. 4, Division of Entomology, U.S. Department of Agriculture, 1896, p. 24). Further, it is mentioned in the report of the outbreak of plague at Sydney, 1900 (p. 40), that *Pulex serraticeps*, a species known to attack man, was found upon the rats examined during that epidemic. This last occurrence is not noted in any other document available to me, and Professor Galli Valerio's comment upon it is that it must be so rare as to be accidental. However this may be, it is clear from the items just quoted that there is need for inquiry as to whether the prevalent species in Europe are also the prevalent species elsewhere. For unless this be shown to be the case statements concerning the habits of *Typhlopsylla musculi* and *Pulex faciatus* are insufficient to negative the idea of the participation of a flea of some kind in the dissemination of plague.

274. In pursuing our investigation of Simond's theory it seemed desirable, in view of what has been said above, to ascertain in the first place the exact species of fleas to be found upon our rats. The opportunity afforded by the receipt of rats for the pathological and bacteriological examinations already described was accordingly made use of to secure specimens of fleas upon them. It usually happened that the carcases of the rats were brought to us wrapped up in paper parcels. To facilitate collection of the fleas, as well as a precautionary measure of protection against possible danger from them, it was made a rule to pour a little chloroform through a small hole in the paper before the parcel was opened. This sufficed to stupefy or kill the fleas, which were then picked up from the paper or obtained from the fur by searching with the aid of a fine-toothed comb. This process was carried out during the height of the epidemic until about 100 specimens were collected; this number being deemed adequate to afford a reliable representation of the species present. The fleas obtained were immediately placed in Xylol and afterwards mounted in Canada balsam for microscopical examination. In classifying the species I have been mainly guided by Mr. Carl Baker's descriptive list (Canadian Entomologist, V. 27), but access was also had to Taschenberg's "Die Flohe," to Neumann's "Traité des Maladies Parasitaires," and to other works of a similar character. I have also to gratefully acknowledge assistance afforded to me by Professor W. A. Haswell, F.R.S., Sydney University, and by Mr. W. G. Rainbow, F.L.S., Entomologist to the Australian Museum, Sydney, who were good enough to examine my specimens and check my determination of species.

275. The initial position of affairs, so far as one could gather it from available documents, was that one might expect to find on the rats two species of fleas—*Typhlopsylla musculi* and *Pulex fasciatus*—and there was a suggestion that at least one other species—*Pulex serraticeps*—might also be found upon them. Actual examination of the specimens collected as above described showed, however, that no less than four species were represented. In accordance with the statements of European and American observers two of the species were *Typhlopsylla musculi* and *Pulex fasciatus*. In confirmation of our previous

report the third species was *Pulex serraticeps.* But the fourth species was one not hitherto mentioned as occurring on ordinary rats. A photograph of this flea (as well as of the other species found) is given in the plates herewith. After long and minute examination I concluded the flea was *Pulex pallidus*, or else was an undescribed very close ally of that species. In this conclusion Mr. Rainbow agrees, as also does Professor Haswell, although the latter points out some minor differences from Mr. Baker's description of the type. I have, therefore, felt justified in referring to the flea as *Pulex pallidus*, at all events provisionally and for the purposes of this report. Mr. Baker states that *Pulex pallidus* has been found on *Mus albipes* (the Abyssinian white-footed rat) in the island of Socotra, and upon *Herpestes ichneumon* (Pharoah's rat) in Egypt, so that its being found here upon a species of rats would be consonant with its already known habits. It is more particularly interesting in being a very near relative of the flea of man—*Pulex irritans*—from which it differs in general size and colour it is true, but otherwise only in details such as the comparative lengths of the tarsal joints, number of joints in labial palpi, and conformation of male generative organs.

276. The species referred to, and henceforward in this report called *Pulex pallidus*, not only occurred on the rats, but was by far the most abundent species present. Of the 100 specimens collected and examined as above-mentioned, 10 were identified as *Pulex fasciatus*, 8 as *Typhlopsylla musculi*, 1 as *Pulex serraticeps*, and no less than 81 as *Pulex pallidus.* The overwhelming percentage of the last-named species removes its occurrence from the sphere of accident; there can be no question that at the time the observations were made it was the prevailing species of flea infesting the rats.

277. In order to determine whether this occurrence of *Pulex pallidus* was a purely local circumstance, or applied also to other parts of Australasia, I addressed a request for specimens to official confreres in the other States of the Commonwealth and New Zealand. I have here to thank Dr. Burnett Ham, of Queensland; Dr. Astley Gresswell, of Victoria; Dr. T. Borthwick, of South Australia; Dr. Blackburne, of West Australia; and Dr. Mason, of New Zealand, for their generous efforts in response. I append hereto a tabular statement of the species found amongst the specimens so kindly forwarded, except as regards those from Victoria which arrived in too mummified a condition for accurate observation. By way of completion I have inserted the figures for Sydney, and those for the fleas forwarded from Newcastle in this State by my colleague, the Medical Officer of Health of the district, Dr. Robert Dick.

TABLE XXVIII.—Showing Numbers and Species of Fleas obtained from different parts of Australasia.

Locality.	No. of Specimens.	*Typhlopsylla Musculi.*	*Pulex Fasciatus.*	*Pulex Serraticeps.*	*Pulex Pallidus.*
Brisbane, Queensland	103	18	....	6	79
Adelaide, South Australia	1	....	....	....	....
Perth, Western Australia...	6	5	....	....	1
New Zealand	56	3	53	....	....
Newcastle, New South Wales	34	24	3	....	7
Sydney, „	100	8	10	1	81
Totals	300	58	66	7	169

278. It will be seen from the table that *Pulex pallidus* was found amongst the specimens from every place except New Zealand. The fact of its presence in Brisbane, Newcastle, Sydney, Adelaide, and Perth, justifies the inference of its general distribution along the east, south, and west coasts of Australia, for it is probably to be found also in Melbourne. As no response was made to my letter to Tasmania, I have no data with respect to that island.

279. *Pulex fasciatus* comes next in point of numbers, but was found in three only of the places mentioned.

280. Specimens of *Typhlopsylla musculi* were nearly as numerous as *Pulex fasciatus*, and were more generally distributed, being actually present in all but one, and probably to be found in all the places mentioned.

281. Least numerous were specimens of *Pulex serraticeps*, which were found only amongst those collected at Sydney and Brisbane. It may be mentioned, however, that some of the dried fleas forwarded from Melbourne appeared to belong to this species.

282. It will be seen from these observations that the ordinary fleas of rats—*Typhlopsylla musculi* and *Pulex fasciatus*—noted by European and American authorities, are well represented upon the rats in this part of the world; that another species, here called *Pulex pallidus*, and not noted by the authorities mentioned, is even more common upon the rats of the Australian continent, and that *Pulex serraticeps* is to be found upon our rats in some instances. Whether or not the number of the latter is so small as to be validly attributable to accident may be left an open question. It is at least certain that *Typhlopsylla musculi* and *Pulex fasciatus* are not the only species of fleas to be found upon rats; consequently inferences based upon observation of them alone cannot be accepted as valid evidence in refutation of Simond's suggestion.

283. By way of corollary to the examination of fleas from rats a similar collection was made of fleas from man. Of 101 specimens thus obtained, 85 were *Pulex irritans* and 16 were *Pulex serraticeps.* It may here be added that a single flea obtained from a wallaby during the prevalence of plague at the Zoological Gardens was a *Pulex serraticeps*, and that numerous specimens obtained from dogs and cats all belonged to this species.

284. As regards the capability of attacking human beings, we have but few observations to report. It happened that whereas during the prevalence of plague, we had no particular difficulty in collecting the 100 specimens mentioned above, yet since the disappearance of the epizoötic the rats examined

have been remarkably free from fleas. Our frequent searches for specimens have been most usually fruitless. It was only now and then that we came across two or three fleas on some particular rat. These rare specimens were either *Typhlopsylla musculi*, *Pulex fasciatus*, or *Pulex pallidus*. Our observations upon their ability to bite us were made during this period of scarcity, so that we were not able to make extensive trials. Our experience as far as it has gone is in accord with the statement that *Typhlopsylla musculi* will not bite man, but we have been bitten by all three pulices. A specimen of *Pulex fasciatus* which bit one of my assistants was afterwards seen by microscopical examination to have its stomach full of fresh (bright red) blood. In some trials with specimens of *pallidus* immediately after they were taken from rats the parasites refused to bite, but a flea of this species bit me readily enough after being kept without food in a glass phial for about four hours. The sensation of the bite, the subsequent wheal, and the presence of bright red blood in the stomach furnished convincing evidence of the parasite's attack upon me. This experience was subsequently repeated upon other persons with like result. As to *Pulex serraticeps*, authorities are agreed that it will bite man, and this is also vouched for by common experience of fleas from dogs and cats.

It will be seen that although we cannot claim to be in a position to make any general statement with respect to the proclivities of the various fleas, the few trials we have made show clearly enough that of the four species found by us upon rats, three—*Pulex pallidus*, *Pulex fasciatus*, and *Pulex serraticeps*—possess the ability to bite human beings. The fact that they could do so as a matter of laboratory observation does not necessarily imply that they would also attack men under more natural conditions; but this does not seem to be an unlikely event, especially if the circumstances be such as to deprive the fleas of ready access to their accustomed pabulum, as must be considered to happen at times in the course of an epizoötic of plague. Upon more than one occasion the officers of this Department in charge of cleansing gangs have reported that the men have been invaded by hordes of fleas when dealing with places at which rats had recently died in large numbers. On two occasions we had the opportunity of verifying the fact that men had been abundantly bitten by fleas, but we did not succeed in obtaining specimens from the men nor from the places concerned. Hence we cannot pronounce as to the species of fleas responsible. In view of the fact that *Pulex pallidus* was the only species occurring abundantly on the rats it naturally falls under suspicion; but there is no certainty that the invading fleas came from the rats, for it is to be remembered that *Pulex irritans* sometimes swarms about habitations. It might be expected that if such fleas came from the rats and could carry plague bacilli with them, the fact would be indicated by some incidence of the disease upon members of the cleansing gangs. It actually happened that six of these men, as well as two rat-catchers associated with them, in all eight persons, became infected with plague. Consequently, although we cannot definitely assert that the fleas commonly infesting rats will of their own accord attack man, there are no data within our knowledge opposed to this eventuality.

The foregoing statements suffice to show that one species of flea—*Pulex serraticeps*—exhibits considerable catholicity in the matter of a host. Mr. Baker mentions various animals upon which it has been found (loc. cit., p. 161), and we have here taken it from cats, dogs, rats, human beings, and a wallaby. In view of the fact that it occurs on both rats and man, it would not be unreasonable to infer that to it, if to any flea, might be attached the suspicion of disseminating plague in accordance with Simond's theory. In this connection it is interesting to note that in Simond's successful transference experiment the fleas concerned are said to have been obtained from a cat. Presumably they or some of them were *serraticeps*. However, two experiments after Simond's plan made in this laboratory with the object of ascertaining if this particular species could act as a carrier of plague from rat to rat yielded negative results.

In the three instances in which plague bacilli were found by us in fleas from plague-stricken rats the species of flea concerned was always *Pulex pallidus*. We are not in a position to state whether or not the bacilli occur in other species of fleas, since we made no systematic observations to determine this point. The circumstance that they were found in *pallidus*, combined with the fact that this species was so abundantly present upon the rats during the epizoötic, brings this flea also under suspicion as a possible transmitter of plague. Although, as already stated, it was ascertained to bite man when hungry, no representatives of the species were found amongst the carefully-searched collection of fleas from human beings. This collection was indeed made after the disappearance of plague from this city—at a period when the rats themselves were almost entirely free from fleas, and so is scarcely adequate to conclusively determine the occurrence or non-occurrence of *pallidus* on man in relation to the question under review. We have been unable to perform any transmission experiments with *Pulex pallidus*. As already stated, the supply of them unexpectedly ran short just at the time when the pressure of work occasioned by the epidemic began to relax sufficiently to enable us to undertake experimental researches. Under the circumstances this flea remains for us merely an object of suspicion to be further investigated if the opportunity presents itself.

With respect to the two remaining species—*Typhlopsylla musculi* and *Pulex fasciatus*—there is nothing to add to what has been said above. For the reason already given, we have not been able to collect them in sufficient numbers for experiment.

The two experiments with *Pulex serraticeps* mentioned above, as well as the two others recorded in the previous report (1900, p. 57), all failed to secure the transmission of plague from infected to healthy rats by means of living fleas. The method we adopted was as follows:—A rat was placed in each of two small wire cages, which were in turn enclosed, with about 4 inches of space between them, within a galvanized iron box. One of the two rats was inoculated subcutaneously with bacilli pestis, and in the course of a day or so, when the animal became sick, a number of fleas was placed upon it. Always the inoculated rat died in the usual time, presented the usual *post-mortem* appearances, and was proved to have died of plague by the usual bacteriological procedures. But always also the companion uninoculated rat remained free from plague. In two instances this survival was shown not to be due to immunity since the rats concerned subsequently succumbed to inoculation with bacilli *pestis*. In the other two instances the companion rats died in one and three days after their respective inoculated associates, but their deaths were not due to plague. The *post-mortem* appearances were not those of plague, nor were bacilli *pestis* seen in smear preparations or obtained in cultures from the blood and viscera. In one of them the blood was teeming with *Trypanosoma*, but beyond this there were no definite indications of the cause of death in either case. It has been our experience that the

particular

particular species of rat (*Mus decumanus*) made use of does not generally survive long in captivity. Thus, although two of the rats died in a suggestive manner, it could not be ascertained that they died from plague.

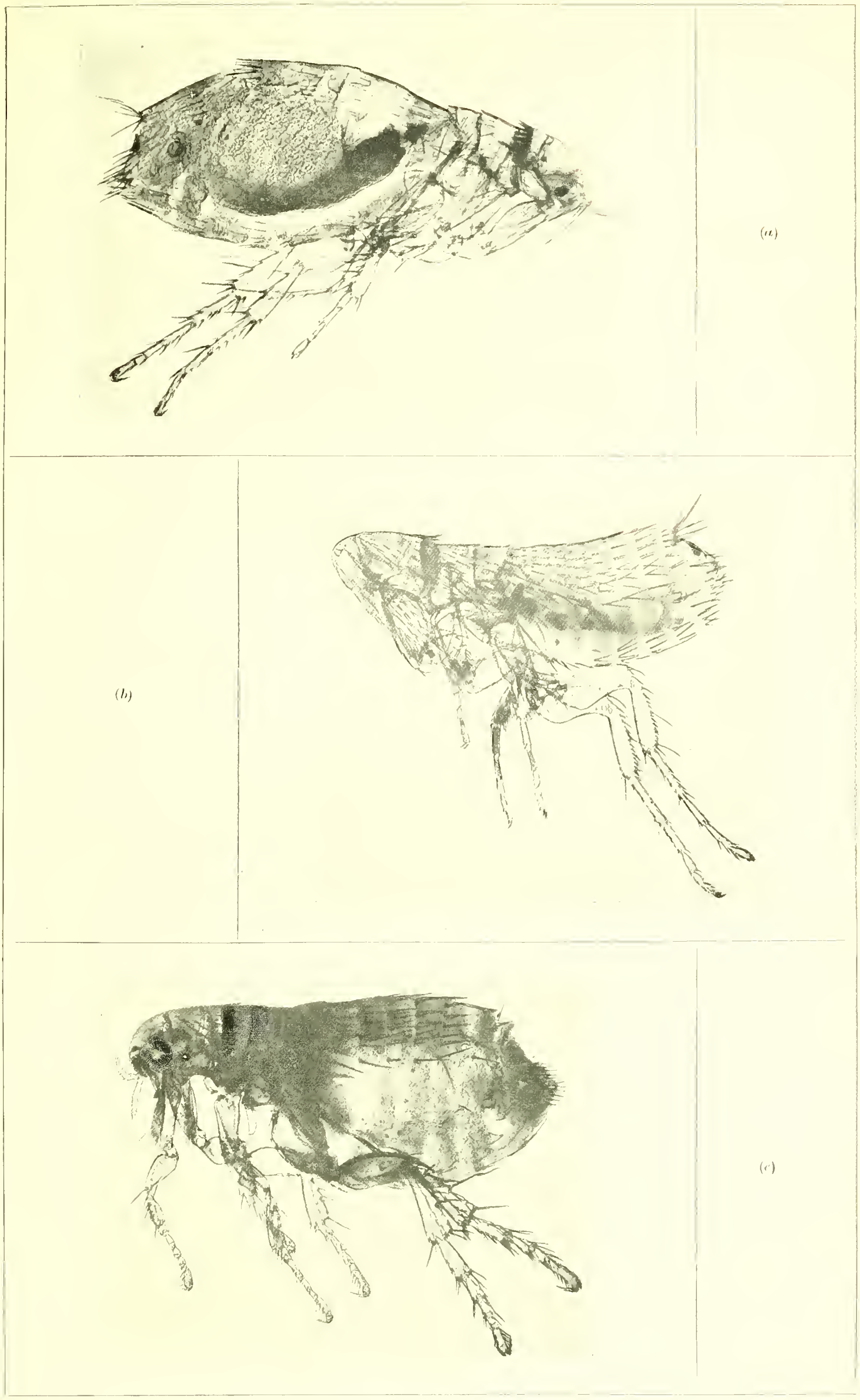
290. The method just described was initially adopted as approximating to that by which Simond obtained success; but a close scrutiny of details reveals it as one very apt to miscarry. For example, in the two experiments more recently performed, the inoculated rats received respectively ten and six specimens of *Pulex serraticeps* obtained from a dog. These fleas promptly disappeared in the fur of the rats, and there our cognisance of them ended. For after death the carcase of the first rat furnished no fleas, and that of the second gave us two specimens of *Pulex fasciatus*. Both carcases had been left untouched for twenty-four hours after death. The carcases of the companion rats being duly searched immediately after their deaths in twenty-four hours and three days respectively after their inoculated associates, yielded, the one a single specimen of *Pulex serraticeps*, and the other, no fleas at all. In the cages we found three specimens of *Pulex pallidus*. After the experiment then we collected 6 fleas, 2 *fasciatus*, 1 *serraticeps*, and 2 *pallidus*—none of which harboured bacilli *pestis*; for smear preparations and cultures from them were all negative. It may be that the single *serraticeps* was one of the sixteen previously placed on the inoculated rats, but this is not certain, and in any case the fate of the other fifteen is not accounted for. It is evident that the method afforded no guarantee that the fleas used actually passed from rat to rat. Some further observations were made by a more hopeful process, kindly suggested to me by Dr. J. S. C. Elkington as having been successfully applied in India by himself and Captain Liston, I.M.S. In this the fleas were retained in test tubes, covered with muslin or chiffon, through which they could bite but not escape. On three occasions fleas were allowed in this way to bite guinea-pigs, sick after inoculation with plague cultures, and, subsequently, to bite other healthy guinea-pigs. The three inoculated guinea-pigs died in the usual time, and presented the usual *post-mortem* appearances of plague, their viscera yielding bacilli *pestis* in abundance. The five associated guinea-pigs also died in periods varying from two to eight days after being bitten by the fleas, but it could not be demonstrated that their deaths were due to plague. In only one instance were the *post-mortem* appearances suggestive of this disease, and from this case a bacillus was isolated, which had, at first sight, considerable resemblance to bacillus *pestis*, but by subsequent investigation was proved not to be that micro-organism. In three of the other animals micrococci only were isolated, and in the remaining one the smear preparations and cultures were all negative. It has to be noted that cultures of blood, taken from the inoculated animals at the time they were bitten by the fleas, yielded bacilli *pestis* in only one of the three, so that there was room for failure in the other two cases. The significant fact of the death of these five animals is not, to my mind, adequately accounted for by the results obtained, and I purpose entering in the near future upon some further experiments with this method. In the meantime, I infer that, although the results obtained by us with respect to the experimental transmission of plague by fleas have as yet been negative, they are properly to be regarded only as inconclusive.

291. Making due allowance for the considerations just presented it will be apparent that whilst the observations made in this laboratory do not furnish convincing proof of the participation of a flea in the dissemination of plague, they are nevertheless all consistent with that hypothesis. We have found that rats coming under our notice during the prevalence of plague harboured more fleas than did those examined after the subsidence of the epizoötic. The fleas collected from them represented four species, of which one—*Pulex serraticeps*—is known to attack man, whilst two others—*Pulex pallidus* and *Pulex fasciatus*—have been ascertained to be capable of doing so. Specimens of one of these species—*Pulex pallidus*—have been three times found to harbour plague bacilli, which produced plague in animals, into which they were inoculated, and were, therefore, virulent. We have also (v. Report 1900, p. 56) found plague bacilli in a phlyctenule, such as has been said to be produced by the bites of infected fleas. Against these various items of positive evidence we have opposed only the results of the transmission experiments which we may not yet consider of final import.

292. It may here be mentioned that the rats were found to be richly infested with bugs. These were in various stages of development, but comparatively few of them were adults. Reference to the authorities of the Australian Museum elicited the information that the species was *Cimex lectuarius*. These parasites continued to occur on the rats after the subsidence of the epizoötic, and are now apparently as numerous as ever. No experimental observations have yet been made with them.

293. A preliminary objection to the hypothesis that plague might be conveyed to man by fleas which had previously bitten rats infected with the disease, has been raised by Nuttall, and by Galli-Valerio; it is, that "rat-fleas" do not bite man. The species of fleas thus referred to by those writers were *Typhlopsylla musculi* and *P. fasciatus*; and these appear to be the species which most commonly infest rats, in some parts of Europe, at all events. The observations now recorded by Dr. Tidswell expose the crudity of this criticism. In the first place, as to the species of fleas which infest rats, he found that, although he was able to collect both *Typhlopsylla musculi* and *P. fasciatus* (Baker), another species, namely, *P. pallidus*, was far commoner on the rats of the Australian coast-line. Here, it may be noted, that Dr. Tidswell first indicated *P. pallidus* as a species commonly infesting rats, an observation which was found to hold good of the rats at Bombay after he had communicated it to correspondents in that city. But, further, the concluding sentence of the abstract paper by MM. Raymond and Gauthier, which is inserted in translation below, furnishes some reason for supposing that the same species might be found on rats in some parts of Europe. And then, secondly, as regards the capacity of the species collected to bite man, Dr. Tidswell tells us that both *P. pallidus* and *P. fasciatus* have done so repeatedly at his hands; it further appears

that



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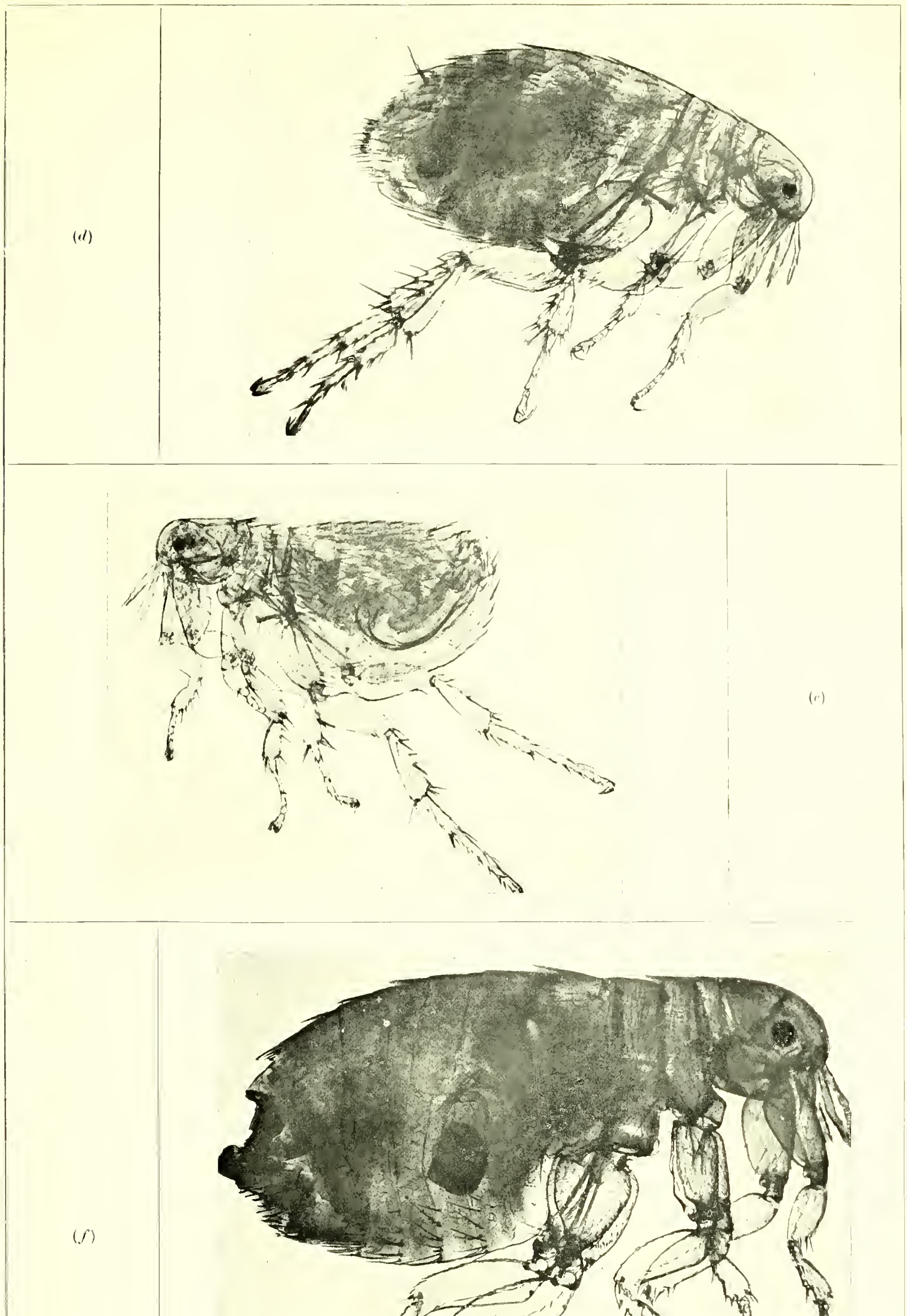
Frank Tidswell.

PHOTOMICROGRAPHS OF FLEAS.

(*a*) PULEX FASCIATUS, FROM RAT. (*b*) TYPHLOPSYLLA MUSCULI, FROM RAT.
(*c*) PULEX SERRATICEPS, FROM RAT.



xc 250

Frank Tidswell.

PHOTOMICROGRAPHS OF FLEAS.

(*d*) PULEX PALLIDUS, F., FROM RAT. (*e*) PULEX PALLIDUS, M., FROM RAT.

(*f*) PULEX IRRITANS, FROM MAN.

that the condition which determined them to bite man was nothing more recondite than hunger. MM. Raymond and Gauthier also found that *P. fasciatus* and *P. pallidus* would bite man. It must, therefore, be considered that the preliminary objection raised by Nuttall, and by Galli-Valerio, has been met; "rat-fleas"—to use the loose phrase employed by those writers for the last time—will bite man. It is probable that *P. pallidus* and *P. fasciatus* do not infest man, and it may be conceded that they do not very eagerly feed on him; the rat, no doubt, is their host of election, although it is plain that they have no repugnance to man. And it appears to me that the phenomena of epidemic plague, as observed at Sydney, require that the intermediary between rat and man should be more usually restrained from acting as such, than encouraged by its instincts to do so. However that may be (for the reader will doubtless reflect that there are other conditions which may act in the same direction of restraint, though by other means) we have here one possible reason why the vicinity of plague-rats is more often harmless to man than it is a cause of plague in him.

294. A further objection has been also raised by Nuttall; it was based on the rapidity with which the bacilli of several diseases, among which plague was not included, lost their virulence after entering the stomach of the flea; this was the result of a long series of experiments performed by him, in which he caused fleas to bite animals previously infected with anthrax, chicken-cholera, and some other diseases. His argument, it will be observed, was from analogy; it now seems to have been met by direct observation. In the first place, MM. Raymond and Gauthier, working at Marseilles, performed many experiments in the transmission of plague from animal to animal, by means of fleas, during the latter half of 1902, and, in December of that year, published the following note, which, on account of its great interest, I take the liberty of translating below:—

> "We have undertaken some researches with a view to test Simond's theory of the share taken by the parasites of the rat in the spread of plague.
>
> "In five experiments we have succeeded in transmitting the plague-septicæmia of an inoculated animal to a healthy animal by placing on the former fleas gathered on shore or ship-rats, and by afterwards exposing the healthy animal to the bites of the insects which had been thus infected.
>
> "On the other hand, we did not succeed in effecting a similar transmission by means of the little acari which rats very often carry, nor by the simple cohabitation of healthy with infected animals.
>
> "We then enquired whether the rat-flea would bite man: 14 insects out of 16 bit at once when they were placed on the human skin after having been kept fasting for twenty-four hours. A few fleas survived for many weeks, having been fed exclusively on man.
>
> "Among the rat-fleas which bit man we were able to examine and determine 8; of these 7 were *P. fasciatus*, the kind most commonly found on rats, while the eighth was a kind of flea which had no comb, very like *P. irritans*, but smaller and paler."*

At a later date the authors published their paper *in extenso*.† From the latter it appears that they placed an infected rat in one compartment of a wire cage, and supplied fleas, collected from ship and from shore rats, to it shortly before its death. They then introduced a clean rat into the other compartment, which was separated from the first by an interval protected by a double grating, which was fine enough to prevent the passage of anything slightly larger than a flea, the interval between the two gratings having been about 2 cm. The whole was enclosed in a ventilated glass vessel, specially constructed so as to allow of access to the interior at the same time that the fleas were securely confined to it. It has been shown, again and again, that plague is not communicated from animal to animal when the healthy are put into cages which contain the body of a rat dead of plague, or when the healthy are placed in cages in which plague-rats have died, so that it may be taken that unless the disease was conveyed by the fleas, the healthy rats would have remained uninfected; but although, in addition, the compartments were so separated that the clean rat could not have reached the body of its previously-deceased companion, the result of these experiments was, it will be noticed, inferential as regards the mode in which the clean rat received its infection. This objection, which had been raised against the successful, though meagre, experiments devised and reported originally by Simond, which were arranged somewhat similarly, has been obviated in the method followed by Dr. J. S. C. Elkington, at Bombay,‡ working under Haffkine in the Plague Research Laboratory. The infected and the clean animals were never within reach of each other. All communication between them, both direct and indirect, was prevented, except that which was the subject of investigation. The fleas were under control, and were placed, first on the infected, then on the clean animal. The clean animals are reported to have died of plague, which can only have been communicated to them by the fleas.

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* Comptes Rendues de la Société de Biologie, LIV, p. 1,497, December, 1902.

† *Revue d'Hygiène*, xxv, p. 426, May, 1903.

‡ *Australasian Medical Gazette*, xxii, p. 348.

295. We have now reached the end of this study of epidemic plague. The conclusions to which it points differ fundamentally from those which are supported in the most recent writings on the aetiology of this disease. No attempt has been made to explain the discrepancies thus brought to light. I have described what we have seen. It is possible that different circumstances, obtaining in other parts of the world, may account for them in some minor respects; such are the comparative magnitude of epidemics, and their longer continuance elsewhere often witnessed. But as regards more general and (aetiologically) more important features, it is difficult to show that they have been modified by circumstances; unless, indeed, the larger proportion of persons dying at home (who, therefore, had bacilli in the peripheral circulation while they were still exposed to the bites of parasites) may have had some influence. On the other hand, the opportunity of making accurate epidemiological observations has often been denied elsewhere by the character and density of the populations among which epidemics have, for the most part, hitherto occurred. For this reason I am inclined to lay stress on our records; and when, after experience of two separate outbreaks, I am able to say that, with us, the disease was in no degree assisted to assume the epidemic form by direct or indirect communication with the sick, and that place-infection, in the Indian sense, did not exist, it becomes probable that the leading part invariably assigned to these factors by writers who have either worked under the unfavourable conditions adverted to, or who have had no practical experience with epidemic plague, as the case may be, requires revision.

296. As for ourselves, we were manifestly compelled to search elsewhere for a competent cause of the epidemics we had witnessed. We first looked for a source of the infection; we were able to find it, and even to surmise its presence, only in the bodies of diseased rats. We then examined into the distribution of cases in relation to the distribution of plague-rats, and we found that there was a singularly close correspondence between the two, both in time and in place. We noticed, again and again, the establishment of new centres of infection at distant and widely separated points, to which fodder had been transported from a line of wharves already known to be infested with plague-rats; and we remarked precedence of the disease in rats over its occurrence in man at those localised centres. But we also observed that on attempting to ascertain a more direct and closer connection between individual cases of plague and presence of plague-rats on the premises which yielded them, we succeeded only rather more often than we failed; although we learned at the same time that the considerable proportion of failures was merely incidental, in all probability, to the search conditions.

297. Nevertheless we met with many individual cases which seemed to throw great doubt on the efficiency of plague-rats as the cause of epidemic plague. We perceived that although neighbourhood of the latter seemed to be necessary to infection of man, contact with them was certainly not necessary; and, which is even more striking, we learned on irrefragible evidence that presence of plague-rats in a building was very often not accompanied by plague in any of the persons who inhabited it. Further, we found that when the presence of plague (or of dead) rats was accompanied by plague in man, by far the most commonly one person alone out of several composing the household was attacked. On the other hand, we often saw several cases arise at the same time among parties of people between whom the sole bond was daily resort to the same places of employment; and while those places of employment were ascertained to have harboured plague-rats, or at all events rats which had died of some epizoötic disease at a time when plague was known to be prevalent among their congeners in the immediate neighbourhood, it was also ascertained that the infected individuals among those who composed the several groups had, each of them, their dwellings in different houses, situated in widely separated neighbourhoods: which dwellings and neighbourhoods furnished no evidence of presence of the infection.

298. These observations, correct as they had been shown to be by repetition, were puzzling in as far as apparent absence of the only recognisable source of the infection did not betoken safety from plague, and in as far as its ascertained presence

was far from being invariably, or even commonly, attended with plague. In this doubt the pathology of the disease came to be reconsidered, in hope that it might furnish some hint pointing to a rational explanation of these apparent contradictions. We recognised the obvious possibility, little likely to be detected by common observation if it were realised, that food might be soiled by passing plague-rats, arrived, perhaps, from premises which they infested, at premises which showed no signs of infestation, but yet yielded cases of plague in man. But this hypothesis it was necessary to dismiss, because there is practically no pathological evidence that man is infected by feeding. If he can be thus infected, it is certain that he is so very rarely indeed; and in that way epidemic plague cannot be explained. On the other hand, the pathological evidence that man is usually infected by inoculation is abundant, uniform, and direct. We considered, then, whether man might commonly become infected by casual contact with virus deposited by plague-rats; for we know that it can be thus deposited, and is likely to be dropped in situations where it may afterwards come into contact with his skin. Thereupon we reflected that a function of the epithelium is to prevent the entrance of infections to the body by way of the skin, and perceived that if this mode is to take effect it can do so only when deposited infection is brought into apposition with a broken epithelium. This, it may be assumed, sometimes has happened; but what is being sought is not an exceptional mode of infection, but one which takes effect so commonly that it may be accepted as a cause of epidemic plague. When, therefore, the very short time is remembered during which such small wounds remain open as alone are in question (because the finding of wounds which might have served as points of entry for the virus in cases of bubonic plague was, in our experience, quite unusual) ; when the comparatively short, though much longer time, during which the virus survives in potentially active form, even under the carefully guarded conditions of a laboratory experiment is considered—a time which probably must be abridged under the conditions of daily life; and when it is noticed how small must be the parts of the ground-surfaces, &c., which can be thus infected, and, consequently, how great are the chances against the minute wound being brought into contact with them within the requisite times, it becomes apparent that the casual inoculation of man in that way is very unlikely to happen often enough to account for epidemics of plague. It is evident that the means by which he is inoculated must operate more directly and certainly than that. The riddle being still unread, we turned again to our epidemiological notes, and re-examined them. We found, without any difficulty, at least twelve out of the 139 cases in which inoculation could not have resulted from casual contact with deposited infection. They showed that in all probability it must have been effected by some agent, to which neither an unbroken epithelium nor protective clothes offered any important obstacle. But obstacles to chance inoculation both of them certainly are. We were unavoidably compelled, therefore, to contemplate an agent of inoculation possessed of means of evading or of overcoming them. In order to evade protective clothes this agent must be endowed with locomotive powers, and it must be capable of penetrating the epithelium without causing either noticeable pain or a visible wound. It is perceived, of course, that the flea best answers to these requirements.

299. As soon as this has been recognised, it also appears that the original hypothesis of the flea, taken in conjunction with recent observations on the habits of this insect, is exactly what is required to reconcile the apparent contradictions described above ; to explain, not merely the erratic incidence of plague, but also the absence of any great probability of the infection being received by man from plague-rats when they are present on inhabited or frequented premises. For we know that the flea which most commonly infests the human race is of one species, while the fleas which infest other sorts of animals are different from it and (as regards several species) from each other ; whence it seems evident, *a priori*, that species so usually associated with this or that sort of animal as to be found with certainty upon it when they are searched for, probably have a predilection for their peculiar hosts. On putting this probability to the test of experience, it is found to be so far well-founded that the species of fleas which infest rats seem, on the one hand, not to infest man, but, on the other, to have no repugnance to him. They will feed freely upon his blood if they be hungry. Hence it is plain that there are at least two chances against man's being bitten by any of the species which infest rats. One is that fleas which have left a plague-rat may never come within

reach of man though on the same premises with him; the other is that, if they reach him, they may do so at a time when they are not so urged by hunger as to bite an unaccustomed host. These chances amply suffice to account for the frequency with which all the persons who inhabit premises which are known to have been visited by plague-rats escape, as well as for the rarity with which more than one person is attacked among a household which consists of many, all of whom are susceptible, and all of whom appear—but only appear—to have been equally exposed to danger.

300. Thus, I have been led to conclude that Simond's hypothesis of the flea best explains the phenomena of epidemic plague as seen at Sydney; not, be it noted, by considerations based on his original assertion that plague could be communicated from animal to animal by fleas, but *a posteriori*—that is to say, by observation of the field-facts, as they may be called, and by inference from the records made day by day after they had been collated and duly weighed. And here I would point out a matter which has been overlooked by those who have unreservedly accepted the hypothesis of the flea before it had been sufficiently tested either in the field or in the laboratory. It is that, after it had been shown that plague could be transmitted by these parasites, the proof that *epidemic* plague was thus caused would still remain to be sought, and could be furnished only by an epidemiological study of the field-facts. It is towards this that I am now able, I submit, to offer a contribution. All that is required to support the conclusion drawn is the laboratory proof that this mode of diffusion of the infection is possible. And this, also, seems now to have been given, not merely by MM. Raymond and Gauthier at Marseilles, but also by Dr. Elkington at Bombay, whose observations are confirmatory of Simond's original experiments made in India as much as five years ago. There are points which still remain to be elucidated. For instance, the facts, as they appear to me, seem to require that the flea should be able still to communicate the virus many hours, and even some days, after it has received it; but, however that may be, this and other such details can be investigated only in the laboratory, and can be determined only by direct experiment. In the meantime I venture to express a hope that the field of epidemic plague, which has hitherto been given over almost entirely to the bacteriologist, and to those who have relied on inferences drawn from his carefully-guarded experiments, may soon begin to be laboured by the professed epidemiologist, whose peculiar function it is to discover and exhibit the phenomena of communicable diseases as they are manifested under the variable conditions of daily life.

J. ASHBURTON THOMPSON.

APPENDIX.

Appendix.

Table showing Serial Numbers, Date of Attacks, Adjudged Places of Infection, and grouping of 139 cases of Plague, together with references to the paragraphs in which they are mentioned.

Serial Number.	Date of Attack.	Adjudged Place of Infection.	Area.															Reference number to paragraph in Report.
			South Central. 1	Paddington. 2	Chippendale. 3	Alexandria. 4	Waterloo. 5	Central. 6	Darling Harbour. 7	Woolloomooloo. 8	Camperdown. 9	North Central. 10	S.W. Central. 11	S.E. Central. 12	Pyrmont. 13	Not within any named area. 14	Undetermined. 15	
	1901.																	
1	4 Nov.	Exton's Store, Hay-street, City	•	...	...	...	...	...	...	...	...	...	...	...	...	...	...	77
2	8 Dec.	Undetermined	...	...	...	...	...	...	...	...	...	...	...	...	...	...	•	85
	1902.																	
3	10 Jan.	145, New South Head Road, Paddington	...	•	...	...	...	...	...	...	...	...	...	...	...	...	...	90
4	12 ,,	285, Castlereagh-street, City	•	...	...	...	...	...	...	...	...	...	...	...	...	...	...	97
5	16 ,,	145, New South Head Road, Paddington	...	•	...	...	...	...	...	...	...	...	...	...	...	...	...	90
6	20 ,,	147, ,, ,, ,,	...	•	...	...	...	...	...	...	...	...	...	...	...	...	...	90
7	19 ,,	115, ,, ,, ,,	...	•	...	...	...	...	...	...	...	...	...	...	...	...	...	90
8	19 ,,	147, ,, ,, ,,	...	•	...	...	...	...	...	...	...	...	...	...	...	...	...	90
9	4 Feb.	Undetermined	...	...	...	...	...	...	...	...	...	...	...	...	...	...	•	45
10	5 ,,	171, George-street West, City	...	...	•	...	...	...	...	...	...	...	...	...	...	...	...	101
11	6 ,,	8, Henderson-road, Alexandria	...	...	...	•	...	...	...	...	...	...	...	...	...	...	...	101
12	5 ,,	167, George-street West, City	...	...	•	...	...	...	...	...	...	...	...	...	...	...	...	101
13	7 ,,	165, New South Head Road, Paddington	...	•	...	...	...	...	...	...	...	...	...	...	...	...	...	92
14	10 ,,	165, ,, ,, ,,	...	•	...	...	...	...	...	...	...	...	...	...	...	...	...	93
15	10 ,,	342, Glenmore-road, Paddington	...	•	...	...	...	...	...	...	...	...	...	...	...	...	...	94
16	9 ,,	376, Pitt-street, City	•	...	...	...	...	...	...	...	...	...	...	...	...	...	...	100
17	11 ,,	217, New South Head Road, Paddington	...	•	...	...	...	...	...	...	...	...	...	...	...	...	...	94
18	14 ,,	Her Majesty's Theatre, Pitt-street, City	...	...	...	...	...	•	...	...	...	...	...	...	...	...	...	212
19	14 ,,	,, ,, ,,	...	...	...	...	...	•	...	...	...	...	...	...	...	...	...	213
20	15 ,,	,, ,, ,,	...	...	...	...	...	•	...	...	...	...	...	...	...	...	...	214
21	12 ,,	,, ,, ,,	...	...	...	...	...	•	...	...	...	...	...	...	...	...	...	211
22	16 ,,	George Hotel, Pitt-street, City	...	...	...	...	...	•	...	...	...	...	...	...	...	...	...	131
23	14 ,,	232, Sussex-street, City	...	...	...	...	...	...	•	...	...	...	...	...	...	...	...	124
24	18 ,,	118, Crown-street, City	...	...	...	...	...	...	...	•	...	...	...	...	...	...	...	198
25	18 ,,	39, Sussex-street, City	...	...	...	...	...	...	•	...	...	...	...	...	...	...	...	127
26	19 ,,	Criterion Hotel, 258, Pitt-street, City	...	...	...	...	...	•	...	...	...	...	...	...	...	...	...	199
27	22 ,,	,, ,, ,,	...	...	...	...	...	•	...	...	...	...	...	...	...	...	...	199
28	22 ,,	224, Sussex-street, City	...	...	...	...	...	...	•	...	...	...	...	...	...	...	...	128
29	21 ,,	Criterion Hotel, 258, Pitt-street, City	...	...	...	...	...	•	...	...	...	...	...	...	...	...	...	199
30	21 ,,	118, Crown-street, City	...	...	...	...	...	...	...	•	...	...	...	...	...	...	...	198
31	23 ,,	Criterion Hotel, 258, Pitt-street, City	...	...	...	...	...	•	...	...	...	...	...	...	...	...	...	199
32	22 ,,	,, ,, ,,	...	...	...	...	...	•	...	...	...	...	...	...	...	...	...	199
33	25 ,,	George Hotel, 186, Pitt-street, City	...	...	...	...	...	•	...	...	...	...	...	...	...	...	...	131
34	24 ,,	47, Market-street, City	...	...	...	...	...	•	...	...	...	...	...	...	...	...	...	217
35	22 ,,	30, Botany-road, Alexandria	...	...	...	•	...	...	...	...	...	...	...	...	...	...	...	109
36	25 ,,	68, ,, ,,	...	...	...	•	...	...	...	...	...	...	...	...	...	...	...	110
37	20 ,,	68, O'Connor-street, Chippendale	...	...	•	...	...	...	...	...	...	...	...	...	...	...	...	102
38	22 ,,	Undetermined	...	...	...	...	...	...	...	...	...	...	...	...	...	...	•	45
39	24 ,,	Criterion Hotel, 258, Pitt-street, City	...	...	...	...	...	•	...	...	...	...	...	...	...	...	...	199
40	25 ,,	,, ,, ,,	...	...	...	...	...	•	...	...	...	...	...	...	...	...	...	199
41	27 ,,	482, George-street, City	...	...	...	...	...	•	...	...	...	...	...	...	...	...	...	134
42	27 ,,	49-51, Sussex-street, City	...	...	...	...	...	...	•	...	...	...	...	...	...	...	...	128
43	27 ,,	47, Market-street, City	...	...	...	...	...	•	...	...	...	...	...	...	...	...	...	217
44	27 ,,	Undetermined	...	...	...	...	...	...	...	...	...	...	...	...	...	...	•	45
45	1 Mar.	30, Botany-road, Alexandria	...	...	...	•	...	...	...	...	...	...	...	...	...	...	...	...
46	3 ,,	General Post Office (?), City	...	...	...	...	...	•	...	...	...	...	...	...	...	...	...	131
47	27 Feb.	17, Brisbane-street, City	...	...	...	...	...	...	...	...	...	...	...	•	...	...	...	...
48	27 ,,	Undetermined	...	...	...	...	...	...	...	...	...	...	...	...	...	...	•	45
49	28 ,,	237, Pitt-street, City	...	...	...	...	...	•	...	...	...	...	...	...	...	...	...	134
50	2 Mar.	Undetermined	...	...	...	...	...	...	...	...	...	...	...	...	...	...	•	45
51	3 ,,	251-257, Pitt-street, City	...	...	...	...	...	•	...	...	...	...	...	...	...	...	...	134
52	11 ,,	Central Exchange Coffee Palace, York-street, City.	...	...	...	...	...	•	...	...	...	...	...	...	...	...	...	204
53	11 ,,	,, ,, ,,	...	...	...	...	...	•	...	...	...	...	...	...	...	...	...	204
54	10 ,,	Undetermined	...	...	...	...	...	...	...	...	...	...	...	...	...	...	•	45
55	12 ,,	155, King-street, City	...	...	...	...	...	•	...	...	...	...	...	...	...	...	...	134
56	10 ,,	123, Sussex-street, City	...	...	...	...	...	...	•	...	...	...	...	...	...	...	...	128
57	10 ,,	170, Pitt-street, City	...	...	...	...	...	•	...	...	...	...	...	...	...	...	...	134
58	5 ,,	Undetermined	...	...	...	...	...	...	...	...	...	...	...	...	...	...	•	45
59	4 ,,	Barker's-lane, off Bathurst-street, City	...	...	...	...	...	...	•	...	...	...	...	...	...	...	...	128
60	13 ,,	Central Exchange Coffee Palace, York-street.	...	...	...	...	...	•	...	...	...	...	...	...	...	...	...	204
61	13 ,,	77, George-street, Camperdown	...	...	...	...	...	...	...	...	•	...	...	...	...	...	...	137
62	16 ,,	5, Chambers-street, City	...	...	•	...	...	...	...	...	...	...	...	...	...	...	...	102
63	15 ,,	Undetermined	...	...	...	...	...	...	...	...	...	...	...	...	...	...	•	45
64	14 ,,	13, Bridge-street, City	...	...	...	...	...	...	...	...	...	•	...	...	...	...	...	218
65	15 ,,	,, ,,	...	...	...	...	...	...	...	...	...	•	...	...	...	...	...	218
66	16 ,,	,, ,,	...	...	...	...	...	...	...	...	...	•	...	...	...	...	...	218
67	18 ,,	111, York-street, City	...	...	...	...	...	•	...	...	...	...	...	...	...	...	...	131
68	18 ,,	73, Engine-street, City	...	...	...	...	...	...	...	...	...	...	•	...	...	...	...	...
69	13 ,,	425, George-street, City	...	...	...	...	...	•	...	...	...	...	...	...	...	...	...	204
			1		3	4	5	6	7	8	9	10	11	12	13	14	15	

Serial Number.	Date of Attack.	Adjudged Place of Infection.	Area.															Reference number to paragraph in Report.
			South Central. 1	Paddington. 2	Chippendale. 3	Alexandria. 4	Waterloo. 5	Central. 6	Darling Harbour. 7	Woolloomooloo. 8	Camperdown. 9	North Central. 10	S.W. Central. 11	S.E. Central. 12	Pyrmont. 13	Not within any named area. 14	Undetermined. 15	
	1902.																	
70	17 Mar.	13, Bridge-street, City	...	...	...	...	...	...	...	...	...	●	...	...	...	...	...	218
71	16 ,,	13, ,, ,,	...	...	...	...	...	...	...	...	...	●	...	...	...	...	...	218
72	17 ,,	Barque "Eulomene" (excepted)	...	...	...	...	...	...	...	...	...	...	...	...	...	...	●	66
73	19 ,,	90, Wyndham-street, Alexandria	...	...	...	●	...	...	...	...	...	...	...	...	...	...	...	108
74	19 ,,	Undetermined	...	...	...	...	...	...	...	...	...	...	...	...	...	...	●	45
75	20 ,,	39, Market-street, City	...	...	...	...	...	●	...	...	...	...	...	...	...	...	...	131
76	16 ,,	105, King-street, City	...	...	...	...	...	●	...	...	...	...	...	...	...	...	...	134
77	26 ,,	109, Quay-street, City	...	...	...	...	...	...	...	...	...	...	●	...	...	...	...	...
78	24 ,,	Saxton and Binn's timber yard, Blackwattle Bay.	...	...	...	...	...	...	...	...	...	...	...	...	●	...	...	220
79	22 ,,	14, John-street, Waterloo	...	...	...	...	●	...	...	...	...	...	...	...	...	...	...	112
80	25 ,,	134, King-street, City	...	...	...	...	...	●	...	...	...	...	...	...	...	...	...	134
81	25 ,,	Strand Arcade, Pitt-street, City	...	...	...	...	...	●	...	...	...	...	...	...	...	...	...	131
82	21 ,,	16, Dick-street, Chippendale, City	...	...	●	...	...	...	...	...	...	...	...	...	...	...	...	205
83	26 ,,	117, Gipps-street, Pyrmont, City	...	...	...	...	...	...	...	...	...	...	...	...	●	...	...	205
84	26 ,,	267, Pitt-street, City	...	...	...	...	...	●	...	...	...	...	...	...	...	...	...	134
85	27 ,,	119, Gipps-street, Pyrmont, City	...	...	...	...	...	...	...	...	...	...	...	...	●	...	...	206
86	27 ,,	Undetermined	...	...	...	...	...	...	...	...	...	...	...	...	...	...	●	45
87	28 ,,	,,	...	...	...	...	...	...	...	...	...	...	...	...	...	...	●	45
88	27 ,,	Union Co.'s Wharf, Margaret-street	...	...	...	...	...	...	●	...	...	...	...	...	...	...	...	267
89	22 ,,	Miller's timber yard, Duncan-street	...	...	...	...	...	...	●	...	...	...	...	...	...	...	...	128
90	31 ,,	20, John-street, Waterloo	...	...	...	...	●	...	...	...	...	...	...	...	...	...	...	112
91	2 April.	119, Gipps-street, Pyrmont	...	...	...	...	...	...	...	...	...	...	...	...	●	...	...	206
92	29 Mar.	16, Dick-street, Chippendale	...	...	●	...	...	...	...	...	...	...	...	...	...	...	...	205
93	3 April.	137, Liverpool-street, City	●	...	...	...	...	...	...	...	...	...	...	...	...	...	...	100
94	3 ,,	Undetermined	...	...	...	...	...	...	...	...	...	...	...	...	...	...	●	45
95	16 Mar.	173, Goulburn-street, City	...	...	...	...	...	...	...	...	...	...	...	●	...	...	...	...
96	5 April.	Undetermined	...	...	...	...	...	...	...	...	...	...	...	...	...	...	●	45
97	6 ,,	45, Riley-street, Woolloomooloo	...	...	...	...	...	...	...	●	...	...	...	...	...	...	...	...
98	13 ,,	1, Bourke-street, Waterloo	...	...	...	...	●	...	...	...	...	...	...	...	...	...	...	112
99	12 ,,	Buckle's Wharf, Blackwattle Bay	...	...	...	...	...	...	...	...	...	...	...	...	●	...	...	220
100	18 ,,	3, Rennie-street, Redfern	...	...	...	...	...	...	...	...	...	...	...	...	...	●	...	181
101	16 ,,	Undetermined	...	...	...	...	...	...	...	...	...	...	...	...	...	...	●	45
102	18 ,,	89A, George-street West, City	...	...	●	...	...	...	...	...	...	...	...	...	...	...	...	102
103	19 ,,	Undetermined	...	...	...	...	...	...	...	...	...	...	...	...	...	...	●	45
104	20 ,,	Gillies' Bond, Grafton Wharf	...	...	...	...	...	...	●	...	...	...	...	...	...	...	...	124
105	20 ,,	66, O'Connor-street, Chippendale	...	...	●	...	...	...	...	...	...	...	...	...	...	...	...	102
106	20 ,,	2, Bathurst-street, City	...	...	...	...	...	...	●	...	...	...	...	...	...	...	...	128
107	23 ,,	60, Phillip-street, Alexandria	...	...	...	●	...	...	...	...	...	...	...	...	...	...	...	111
108	27 ,,	245, King-street, Newtown	...	...	...	...	...	...	...	...	...	...	...	...	...	●	...	146
109	26 ,,	31, Raglan-street, Waterloo	...	...	...	...	●	...	...	...	...	...	...	...	...	...	...	112
110	24 ,,	Undetermined	...	...	...	...	...	...	...	...	...	...	...	...	...	...	●	45
111	28 ,,	,,	...	...	...	...	...	...	...	...	...	...	...	...	...	...	●	45
112	27 ,,	26, Campbell-street, City	●	...	...	...	...	...	...	...	...	...	...	...	...	...	...	100
113	30 ,,	59, Goulburn-street, City	●	...	...	...	...	...	...	...	...	...	...	...	...	...	...	100
114	24 ,,	69, William-street, Woolloomooloo	...	...	...	...	...	...	...	●	...	...	...	...	...	...	...	...
115	4 May	Retreat-street, Alexandria	...	...	...	●	...	...	...	...	...	...	...	...	...	...	...	112
116	4 ,,	305, Pitt-street, City	...	...	...	...	...	●	...	...	...	...	...	...	...	...	...	131
117	3 ,,	25, Campbell-street, City	●	...	...	...	...	...	...	...	...	...	...	...	...	...	...	100
118	26 April	Undetermined	...	...	...	...	...	...	...	...	...	...	...	...	...	...	●	45
119	5 May	,,	...	...	...	...	...	...	...	...	...	...	...	...	...	...	●	45
120	5 ,,	,,	...	...	...	...	...	...	...	...	...	...	...	...	...	...	●	45
121	8 ,,	,,	...	...	...	...	...	...	...	...	...	...	...	...	...	...	●	45
122	5 ,,	127, Crown-street, Woolloomooloo	...	...	...	...	...	...	...	●	...	...	...	...	...	...	...	...
123	6 ,,	Buckle's Wharf, Blackwattle Bay	...	...	...	...	...	...	...	...	...	...	...	...	●	...	...	220
124	12 ,,	72, William-street, Woolloomooloo	...	...	...	...	...	...	...	●	...	...	...	...	...	...	...	267
125	11 ,,	Gray's Stables, Elizabeth-st. Waterloo	...	...	...	...	●	...	...	...	...	...	...	...	...	...	...	112
126	15 ,,	26, Campbell-street, City	●	...	...	...	...	...	...	...	...	...	...	...	...	...	...	100
127	13 ,,	49, George-street, Camperdown	...	...	...	...	...	...	...	...	●	...	...	...	...	...	...	139
128	16 ,,	Undetermined	...	...	...	...	...	...	...	...	...	...	...	...	...	...	●	45
129	15 ,,	252, George street, City	...	...	...	...	...	...	...	...	...	●	...	...	...	...	...	...
130	15 ,,	86, Windmill-street, City	...	...	...	...	...	...	...	...	...	...	...	...	...	●	...	41
131	20 ,,	Undetermined	...	...	...	...	...	...	...	...	...	...	...	...	...	...	●	45
132	29 ,,	69, Beaumont-street, Waterloo	...	...	...	...	●	...	...	...	...	...	...	...	...	...	...	112
133	28 ,,	Grimley's Tannery, Botany-road, Alexandria.	...	...	...	●	...	...	...	...	...	...	...	...	...	...	...	112
134	5 June	Zoological Gardens	...	...	...	...	...	...	...	...	...	...	...	...	...	●	...	178
135	5 ,,	30, McEvoy-street, Waterloo	...	...	...	...	●	...	...	...	...	...	...	...	...	...	...	112
136	1 ,,	Undetermined	...	...	...	...	...	...	...	...	...	...	...	...	...	...	●	45
137	2 ,,	77, Cooper-street, Waterloo	...	...	...	...	●	...	...	...	...	...	...	...	...	...	...	112
138	5 ,,	17, Botany-street, Waterloo	...	...	...	...	●	...	...	...	...	...	...	...	...	...	...	112
139	8 ,,	54, Morehead-street, Waterloo	...	...	...	...	●	...	...	...	...	...	...	...	...	...	...	112
			1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	

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NEW SOUTH WALES.

REPORT

OF THE

BOARD OF HEALTH

ON A

THIRD OUTBREAK OF PLAGUE AT SYDNEY,

1903.

BY

J. ASHBURTON THOMPSON, M.D., D.P.H., President,
Chief Medical Officer of the Government.

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7th December, 1904.

ATTACK occurred in the last case of the preceding outbreak on 12th June, 1902; the last plague-rat was taken on 14th July, 1902. The outbreak now to be described began in an epizoötic of plague of which the first evidence was got on 12th May, 1903, and the last on 15th August, 1903. It consisted in occurrence of a case of plague in man, in which the date of attack was 17th June, and of one other in which the date of attack was 2nd July; both of these persons recovered. But it is necessary to review the plague-free period which preceded this third outbreak, as well as a part of the plague-free period which followed it; and therefore the account relates to the year and a half which lay between 15th July, 1902, and 31st December, 1903.

2. For descriptive purposes the term just defined may be divided conveniently into three periods, namely (*a*) from 15th July, 1902, to 30th April, 1903, being the preliminary plague-free period; (*b*) from 1st May, 1903, to 15th August, 1903, being the epizoötic period;* and (*c*) from 16th August to 31st December, 1903, comprising a large part of the ensuing plague-free period.

3. During the first period the agencies through which watch was kept on the state of the rat-tribe were a staff of rat-catchers attached to this Department, and a similar staff employed by the Local Authority under the Public Health Act for the City of Sydney; the former was under direction of the headquarters staff, the latter under that of Dr. W. G. Armstrong, M.B., D.P.H., Senior Medical Officer of Health for the metropolitan district and titular City Health Officer (*see* Sydney Corporation Consolidation Act of 1902, sec. 59). These rat-staffs continued to work as they had done for long before; that is to say, the Departmental rat-staff attended to that part of the wharf-line which extends from Pyrmont to the eastern head of Woolloomooloo Bay and to the buildings on, or immediately adjacent to, it (*see* Diagram); it also did some occasional work in suburbs outside the City proper. The City rat-staff attended to the whole of the City proper, except the wharf-line, &c. Both used the same methods. They employed traps exclusively, and that kind of open trap in which the animal's neck is broken as soon as it takes the bait, this having been considered to have proved the best form for continued use. Each man set about three dozen traps at night. Members of the Departmental rat-staff attached the addresses at which animals had been taken to each lot, and delivered the carcases at the Micro-biological Laboratory between 9 and 10 o'clock a.m.; there they were examined by a staff of experienced laboratory assistants under supervision of the Principal Assistant Medical Officer of the Government and Micro-biologist (Dr. Frank Tidswell, M.B., D.P.H.), who was responsible for all bacteriological determinations of plague in carcases, as well as in all specimens from the human body (for methods employed *see* Report, 1900, Appendices A and L, and Report, 1902, pars. 158 to 163). From the beginning of 1903 the Departmental staff was directed to confine its operations entirely to the wharf-line and adjacent buildings; and as it became important to know not merely where rodents had been taken, but also that all the wharves had been regularly visited, they were then instructed to make daily return of all the wharves at which they had set traps, whether animals had been caught or not.

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* Thus extended by eleven days for simplification of the analysis, in view of the probability that the epizoötic had begun some unascertainable number of days before the date of its discovery.

4. Under these conditions 25,664 rats were taken by the two rat-staffs between 15th July and 31st December, 1902; 12,051, or an average of about 70 a day, being all which had been taken by the Departmental staff, were examined in the laboratory (*see* Report, 1902, par. 235). From 1st January to 30th April, 1903, 5,411 rodents were collected by the Departmental staff, of which 5,109 (or an average of about 44 a day) were examined in the laboratory. So that during the whole of the first term from the 15th July, 1902, to 30th April, 1903, 31,075 rodents were taken, of which 17,160 were examined in the laboratory: and they had been taken in neighbourhoods selected in accordance with the experience which had taught that recurrent plague would probably first betray itself in them. None of the 17,160 were infected with plague. Additionally, a few had been handed in occasionally by the City staff, all of which were also healthy; the Senior Medical Officer of Health had reported that nothing to arouse suspicion had been observed in the inland parts of the City which were more immediately under his notice; and on the whole it appeared on 30th April, 1903, to be probable that Sydney had for eight months and a half been really free from plague in its rats, as it certainly had been free from plague in man.

5. Before passing on to speak of the rats collected during the second of the three periods, other work which had been done, and which was still being steadily continued, must be mentioned. In accordance with the general teaching of the two earlier outbreaks (*see* Reports, 1900 and 1902, *passim*) attempts had been made from a very early date to cause Local Authorities under the Public Health Act to render warehouses and food-stores of all sorts, but especially produce stores (in which chaff, hay, maize, lucerne, potatoes, and the like are kept) less accessible to rats, and less likely to harbour them, by obliging owners to make good casual openings in walls and doors, to defend permanent openings with wire-netting, and to substitute solid concrete for wooden flooring in basements. Within the City the Local Authority had most earnestly and most persistently taken up this line of preventive work, and had prosecuted it with much success; and it had done so especially on the eastern side of Darling Harbour, where not only is the produce trade chiefly carried on, but where also the two preceding outbreaks had beyond reasonable doubt taken their local origin. This neighbourhood fell under two authorities. The premises on the western (or water) side of Sussex-street, were vested in the Harbour Trust; those on the eastern side of that street were occupied by various owners in the usual way: But both of these parties were equally subject to the provisions of the Public Health Act under administration within the City of the City Corporation. On the water-side of this street, then, the work now referred to had been steadily prosecuted by the Harbour Trust during the preceding two years, and many (but far from all) premises had been put into satisfactory condition. As regards the eastern side of the street and the rest of the City behind it, the Senior Medical Officer of Health had, in 1901, formed the opinion that progress in this direction would be facilitated by special by-laws, and had presented a code to the Local Authority for the City, which was adopted by it, and which had come into force on 20th February in that year. Then, in view of the dissemination of plague *per saltum* which had so often been observed—a mode of diffusion in which the infection is conveyed with produce from the focus to some distant store, where it is communicated to the local rats and may form the starting-point of an independent sub-epidemic (*see*, for instance, Report 1902, Paddington, Alexandria, &c., &c.), a Model Code of By-laws was framed by the Board to empower Local Authorities to effect similar improvements in municipalities outside the City. All Local Authorities in the Metropolitan District were invited to adopt this Code, which is printed in Appendix B. There also is shown the proportion of them which voluntarily adopted it, and the number in respect of which the Board ultimately had to exercise the powers of compulsion conferred upon it by the Public Health Act of 1902, section 25. Within the City, then, and more especially in that part of it which experience had shown to be most fraught with

danger in relation to plague, much preventive work of great importance had been effected, and still was being effected when this third outbreak began, first by the Local Authority for the City under advice of the Senior Medical Officer of Health, and secondly by the Harbour Trust voluntarily working towards the same end with advantage of the same advice. That end was the keeping of rats outside premises, in accordance with the most important of the practical conclusions drawn from the teaching of the first outbreak (Reports, 1900, p. 47. and 1902, par. 9).

6. Description of the second period, or that during which epizoötic plague was again observed may now be entered upon; it is dated 1st May to 15th August. On 8th May a firm of produce merchants trading at 153 Sussex-street (on the western, or water, side), made a communication to this Department in consequence of which rat-catchers were told off to watch the premises. They succeeded in catching one rat on the night of the 8th, and another on the 10th; both were healthy. On 12th May a further message was received, in response to which Departmental Sanitary Inspector Lloyd was sent down; he collected three carcases, of which one was putrid, one was healthy, and one (of a rat which had been killed by a dog in his presence) was infected with plague, as revealed by the positive results of the morphological and cultural tests applied to it by the Microbiologist. Exit of stock from the premises was at once prevented, and a large gang of men was put in to turn it over. On 13th May, this gang delivered two more carcases at the laboratory, both of which were infected. The stock consisted of maize and chaff. The bags in which the maize was contained were in good order, and were not further interfered with; but many of the chaff bags were broken, and it was thought prudent to cause 650 of them to be sent to a garbage destructor, in which they and their contents were destroyed by fire. In the course of doing this two rats happened to be seen to issue from one of the bags. The premises were part of a row of five houses all similarly constructed, and all in free communication with each other for rats. Sussex-street, at the part now referred to, ran along a low cliff, so that these and some other buildings had but one storey visible from the street, but other two storeys below it which could be entered at the wharf-level behind. Of the three floors of which the building thus consisted, the lowest had been concreted by the Harbour Trust; the other two were of timber, not ceiled. The premises were clean and well-kept, although very old, and presented little harbourage for rats except among the stock.

7. As soon as recurrence of infection among the rats had been thus discovered, the strength of the Departmental and of the City rat-staffs was increased; and the latter was then directed to attach addresses to its takes, and to deliver all carcases at the Microbiological Laboratory. The Board also determined that it was expedient again to offer a capitation-payment of 6d. for each rat brought in by the general public, and to this was added, for the first time, a capitation payment of 1d. for each mouse. No other limit could be set to the area over which rats might be gathered by the public than that of the metropolitan district; and it was considered that, as a rule, no trustworthy statement as to the premises on which particular rats had been taken could be got from them. A furnace was re-established at a convenient point where the officers in charge were chiefly employed in counting, paying for, and burning the rats tendered to them; but they also had instructions to make such inquiry as was possible, and to note any information of importance which came to their ears. In this way a few enterprising people who thought it worth their while to import parcels of rats from a distance were checked, and occasionally an item of information of more or less value was picked up; but, on the whole, payment of capitation money must be regarded only as a means of securing the destruction of rats. This result must be sharply distinguished from that attained by agency of the organised and carefully supervised rat-staffs, which latter are rather a means of getting intelligence than of destruction.

8. The general plan of action in relation to search, and to treatment of premises on which infected rodents were discovered, was the following:—While 153 Sussex-street and some adjacent buildings were being examined by Departmental officers (operations which resulted within a few days in detection of infected rodents at Nos. 151, 139, and 129*, see Appendix A) a special gang of men, which included a plasterer, was put at disposal of the Senior Medical Officer of Health by the Harbour Trust, which, under his direction and that of the Trust's Engineer, went systematically through the Trust's property on the water-side of that street. A similar gang was

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* All odd numbers in this street lie on its water side.

reorganised by the Local Authority for the City, which went through other properties in that immediate neighbourhood on the eastern side of the street, as well as elsewhere within the City. The plasterer's business was to stop the rat-holes which were very numerous in the old, thick, rubble-built walls of some premises. In this way a great deal of work was rapidly done of a kind which experience had shown to be of the greatest importance in checking epizoötic plague. It consisted primarily in moving and re-stacking stocks of fodder and produce, examining them for live or dead rats, cleansing where necessary, and stopping rat-holes permanently; secondarily, in serving notices on the Harbour Trust and on other owners requiring them to defend permanent openings with wire-netting, to repair casual openings, to remove wood-flooring in basements, and to substitute concrete for it. When either of the intelligence-staffs delivered a plague-rat at the laboratory the information, if it concerned premises within the City, was communicated to the Senior Medical Officer of Health, who at once entered the premises on which the animal had been taken, and the premises on each side of them as well; he also concentrated his intelligence-staff in the neighbourhood. If it concerned premises outside the City, similar steps were taken by the Departmental staff, other Local Authorities having been rarely in a position to take effective action with the necessary promptitude. I have no doubt that by these thorough measures—aided by the autumn and winter seasons which, however, I do not suppose to have acted in any of those obscure ways usually classed as "meteorological"—spread of the epizoötic was interrupted, delayed, and ultimately checked, and that development of an epidemic was prevented; for at Sydney epidemic plague has always been directly dependent on epizoötic plague. There the rat has been the sole source of infection for man (Cf. Reports 1900 and 1902 *passim*).

9. Now, as regards rodents taken during this second period, 1st May to 15th August, the two intelligence-staffs delivered at the laboratory 8,695 rats and 5,976 mice, all of which were there examined. Of the total 14,671 rodents (which were examined at the rate, therefore, of just under 1,000 a week, or about 166 a day), 111 rats and 50 mice were ascertained to be infected with plague. The last plague-rodent was brought in on 15th August. The Departmental staff had still confined its attention to the wharf-line as defined in paragraph 3.

10. Then, as regards the third period, namely, from 16th August to 31st December, 1903, the number of rodents collected by the two intelligence staffs was 8,485 rats and 4,904 mice, total 13,389. The deliveries were at the average rate of about 111 a day; all were examined in the laboratory, and none were infected. The Departmental staff had continued to attend to the wharf-line. Thus, at the end of 1903 it once more appeared that Sydney was free from epizoötic plague, and that it had been so for four months and a half.

11. The results achieved through the offer of capitation-money may be briefly reviewed; but as these consisted merely in destruction there is no object in dividing the period, and the whole term from 30th June, 1903, when capitation-money began to be paid to the end of the year may be dealt with at once. During that term of six months 46,472 rats and 22,814 mice were paid for. The record showed that the numbers delivered at the furnace varied very widely between a maximum of 666 and a minimum of 118 a day for rats, and between 322 and 28 a day for mice; but if the gross returns for successive weekly periods were considered, it appeared that these were nearly uniform. Thus the account yielded no evidence that this slaughter (to which should be added the number collected by the intelligence-staffs during the same six months, the whole furnishing a grand total of 88,829 rodents destroyed) produced such an impression on the general horde as rendered collection progressively more difficult; and there was no ground for inferring that any material impression had been thus made on the total rat-tribe. This result was in accordance with the opinion I expressed at first (Report, 1900, p. 47, for instance) namely, that extermination of rats on any large area was practically impossible;* and perhaps no more could be expected from such operations conducted in a district which carried residences housing about 500,000 persons, as well as other buildings. It is fortunate, therefore, that repeated experiences have shown that very strenuous efforts to destroy rats need be made only on those premises, and in their immediate neighbourhood, to which the discovery of one or more plague-rats by intelligence-staffs has

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* By the methods described above. Further attempts to employ Dr. Danysz' cocco-bacillus usefully are being made.

directed attention; and, further, that during plague-free intervals the work of intelligence-staffs may be concentrated on and confined to that neighbourhood which local experience has shown to be the focus of danger for the city to be defended, or at least to be the locality in which a fresh outbreak is most likely first to take place.

12. One other note may be made, which concerns the difficulties which rat-catching appears to present even to experienced men. The figures now to be mentioned in illustration of this point, are to be regarded apart from those given above, under which they have already been included. During the eight months between 1st May and the end of the year the Departmental intelligence-staff paid 17,656 visits to wharves, piers, foreshores, &c., and to the open or bonded stores and sheds immediately connected with them; but only 4,095 of those visits were successful (or, resulted in captures), and the number of rodents taken was only 10,579 (Cf. Report 1902, par. 114). The premises thus examined were freely open to the appointed rat-catchers, yet their efforts were successful only in about 25 per cent. of their attempts. It will not fail to be noticed that when the object is to investigate a residential area, on which such efforts are impeded by the not unnatural reluctance of householders to admit men who are not personally known to them to their premises at night, the thoroughness of the search actually made, and consequently the value of any negative statement in which it may result, remains doubtful. Nevertheless, experience has shown that such searches have a greater practical value than the facts strictly reviewed would seem to warrant.

13. Before bringing this statement to a conclusion attention may be directed to the extremely small proportion borne by the number of rodents in which plague was identified to the total rodents taken. Such a rate must be struck, of course, with carcases in which plague was identified, on the rodents taken and submitted to examination during that term (the second) which was defined by the first and last findings of plague-infected rodents; and the total can comprise only the rodents taken by the intelligence-staffs, because there is no evidence that the epizoötic extended at any time beyond the neighbourhoods in which they worked. Under these limitations the gross percentage of plague-rodents identified was no more than 1·27 per cent. for rats, and 0·83 per cent. for mice; and the smallness of these percentages is accentuated by the fact that of the total 161 plague-infected rodents, no less than 78 were collected from one premises (a secondary focus; Gray's stables, Waterloo, *see* par. 25 below). If this number be subtracted from the total, then it appears that only 83 plague-rodents were identified in the whole of the infected district which included the original focus and all areas (except Waterloo) infected from it; so that the percentage of identified plague-rodents to the total taken by the intelligence-staffs falls to ·55 per cent. for rats, for mice to ·58 per cent., the gross percentage having been ·56 per cent. But there are several considerations which show that such comparisons, if they are made with a view to gauging the severity of an epizoötic, are illusory. The most important of them has been mentioned already (Report, 1902, par. 115); it is that the only methods practically available to rat-catchers tend to ensure capture of healthy rats for the most part. Those alone are taken in traps (as a rule) which are in good health, and which enter them in course of their active search for food, or, if infected, have not reached a stage of illness at which pathological signs have appeared. Hence the percentage of identified plague-rats thus calculated must always be extremely small. An additional reason can be assigned for the low percentage which our accounts show; this attaches to the manner in which I think it best to state the facts. A considerable number of carcases have been delivered at the laboratory in a state too putrid for useful bacteriological examination, but in which there was every reason to think plague had been the cause of death; and were these counted as plague-rats the percentage would be increased. But I do not think the term "plague-rat" should be applied to any carcase in which the disease has not been identified; and I do not think that the term "identified" should be employed unless the presence of *B. pestis* has been bacteriologically demonstrated.

14. From all this it follows that percentages so struck are useful only in as far as they show the practical difficulties there are in the way of capturing plague-rats, and of identifying the disease which has destroyed them (Cf. Report 1902, par. 5, and elsewhere); a difficulty which, so far, has been generally overlooked, and which, I think, has not been fully appreciated by all even of those who have

attempted to investigate rat-plague in a practical way, but by methods insufficiently systematised. Until it shall have been clearly recognised, and the full weight allowed to it with which it is invested by ascertained facts, the rôle of the rat in relation to epidemic plague will continue to be generally considered obscure.

15. It also follows that if it be desired to measure the extent to which an epizoötic of plague has been fatal, the rate must be struck with plague-rats identified at particular premises on the total rats infesting them. But here, again, difficulties will be met with which are quite insuperable. In the first place, the number of the horde which infested the building never could be ascertained; in the second, certainty that the plague-rats identified comprised all which had died of plague never could be reached. For, while in several instances which have been already recounted (Report, 1902, pars. 78, 84, 106, 111, 145, 201, and par. 25 below) very considerable numbers of carcases have been found, the rule has been to find but few, even on premises where it seemed certain the disease had had every opportunity of spreading. This I have ascribed to death of many of the infected animals in burrows, and to the eating of some carcases by other rats.* If it should be suggested that the former might be dug out, it can be replied that apart from all considerations of time, &c., this often could not be done with safety to the building, and even that cases have occurred in which all dead rats could not have been uncovered except by destruction of the lower part of its walls. The practical conclusion, therefore, is that which has already been stated (Report 1902, par. 118); intelligence-staffs can indicate the area over which an epizoötic has extended, but not its severity. Consequently, the identification of plague in a single carcase is a sufficient and an urgent call for presence of the cleansing-staff on the premises which yielded it, and for concentration of the intelligence-staff in their neighbourhood. The present account shows clearly that action thus guided, and promptly taken, may be successful in limiting and checking an epizoötic, and in avoiding occurence of a general epidemic.

16. From the foregoing statement we may proceed to investigate the localities in which plague-rodents were detected. The total 161 were taken on 25 separate premises (including the barque "Alsterschwan"), between the 12th May and 15th August. The position of each place is shown on the accompanying Diagram by spots; these are consecutively numbered in order of the earliest date on which a plague-rodent was observed at each place. In a Table printed on the Diagram are shown the addresses of the places, and these are consecutively numbered to agree with the numbers affixed to the spots; to each address is appended the earliest and the latest date on which plague-rodents were found at it. The course of discovery can be easily followed with this assistance, but this must not be taken without reserve as indicating the progress in place of the epizoötic itself; for although it appears that freshly-infected spots were discovered as a rule soon after the infection had reached them (because very little evidence of local spread from such spots was acquired in spite of close search for it), yet some delay must generally have occurred, so that it is not likely they were discovered precisely in the order in which they became infected.

17. If, now, these 25 infected places are considered in detail after examination of the local conditions in the light of previous experience, it appears that they may be divided into four clearly-distinguishable groups. Thus, in consideration of the negative evidence furnished by the long-continued watch kept on the rats, and especially on the rats of the wharf-line, which has already been described (pars. 3, 9, 10) it seems probable that the Diagram numbers 1, 2, 3, and 4 indicate the neighbourhood of original infection or primary focus, and that the numbers 6, 9, 7, 10, 12, 13, 14, 17, 18, 19, 20, 21, and 23, most probably indicate gradual spread from it by contiguity, although there is a possibility that some of them indicate places to which the infection was conveyed *per saltum*. The numbers 5 and 8, situated far away from the primary focus on the shores of Woolloomooloo Bay, indicate points to which the two infected carcases to which they refer must have been conveyed either

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* About 8 per cent. of carcases delivered at the laboratories are found to have been gnawed or partly eaten. But, although this figure results from test-enumerations, circumstances connected with administrative exigencies reduce it to the status of an estimate. Each rat-catcher must, in the course of each week, hand in a certain minimum number of rats which is accepted as evidence of his attention to duty; and only those carcases can be credited to him which are approximately entire, for if a head or hind-quarters were counted one rat might be made to swell the credit of two men. Now, a considerable number of rats (the proportion is not known) are so eaten that heads separated from the remains of hind-quarters are all that is left of them; and as these pieces are not counted, so they are not often brought in.

overland with goods or by water; and perhaps these two specimens comprised all which were present there, for long-continued search among the wharves and among the houses in their vicinity failed to furnish any evidence of spread of the infection to the local rats. After two months of this search a further single plague-rat was brought in from land attached to an unoccupied private residence standing at the eastern head of this bay (Diagram, No. 22); but in this case again watch was continued afterwards and failed entirely to reveal any infection of the rats in that neighbourhood. It must be supposed, therefore, that this animal also had in some way been carried to the place where it was found. With these instances of transported plague must be included those indicated by the numbers 12 and 13, for these wharves were not only rather distant from the primary focus, but were effectually separated from it on the wharf-line by a large gas-works, as well as in other structural ways; and it may be noted that they were in the neighbourhood of a China wharf to which much fodder, consigned to China, was from time to time conveyed from Sussex-street stores. Lastly, the number 25 must be added to this group; the solitary carcase to which it refers having most probably been transported to the place where it was found, in which no other infected animals could be discovered. The numbers 11, 15, and 16 remain; they are grouped together at a point 2 miles to the south of the primary focus. Doubtless the infection was transported with produce to 11, which was a large stable. The premises afterwards formed a secondary focus from which infected rats spread by contiguity to 15, a soap-works near by, and to 16, a street at some little distance in a different direction; but general infection of the rats in the neighbourhood, although they were numerous, did not occur. Lastly, 24, indicates a ship alongside to which, as well as to the stables just mentioned, further reference will be made below.

18. Thus it is possible to distinguish an original focus, spread from it in its immediate neighbourhood by contiguity, and infection *per saltum*, of at least three distant points; namely, Woolloomooloo Bay, Miller's Point, and the stables at Waterloo. The latter premises afford a further instance of the manner in which secondary foci may become established which is on all-fours with several previously described (Report 1902, Paddington, Alexandria, &c., &c.,) although it was not followed by any epidemic.

19. The course of the epizoötic just described was marked by occurrence of two cases of plague in man. Time-relations are shown in the Table printed on the Diagram, on which, also, the places at which the patients were employed are indicated by the capital letters A, and B, while the situation of the dwellings they occupied is indicated by the corresponding lower-case letters within a circle. The particulars of the first case were as follows:—

CASE A.

Summary.—W.W., m., aged 15, 9/12; apprentice at a printer's. No former attack; not inoculated. Residence, View-street, Annandale, a suburb about 2 miles westerly from his place of employment, which was at 44, Pitt-street, City. Notified by a friend 20th June; visited 20th June by the Assistant Medical Officer of the Government (Dr. R. J. Millard, M.B., D.P.H.), at Annandale, 12·30 p.m.; admitted to hospital, 20th June; discharged, 20th August; duration of illness, 65 days. Left femoral bubo; morphological and cultural tests positive.

Movements prior to Attack.—Had gone to work regularly for several weeks before attack; went and returned by ferry-boat; left work at 5·30, and had travelled by the 5·50 boat for a long time past; took his lunch with him from home, ate it at the shop, or sometimes on Circular Quay near by; in the evening often went to see a friend at Balmain,; Sunday, 14th June, on which date the seventy-two hours preceding attack commenced, was spent as follows:—Stayed at home till 2·45 p.m., went to Sunday-school till 4 p.m., from then till 5 p.m. sat in Wentworth Park, returned home and stayed there. Said that about 10th June he and another apprentice (who was ill at the date of inquiry, was visited, and was found to be free from suspicion of plague), had killed a rat in the composing room; the premises swarmed with fleas.

History of Illness.—June 17th, was well on rising; went to work as usual; at midday began to feel pain in the left groin and in back of head and neck; vomited several times; ate some lunch, but vomited immediately afterwards; got worse, and went home at 3·30; medical advice was not sought. Subsequent symptoms were pyrexia, vomiting, headache, and delirium, especially at night; the bubo increased and became more painful. At examination, 20th June, mid-day, the gland was as large as a pigeon's egg, some periadenitic effusion, tender. No breach of the epithelium of left lower extremity (nor elsewhere).

Residence.—A brick cottage of two rooms; semi-detached; state of repair and cleanliness, fair; pail-closet. It stood next to a large box-factory. Disinfected 20th June.

Employment.—A brick building of five storeys, occupied by a printing firm (job; paper from England, America, Holland, and Belgium, after passing through Sydney warehouses); good repair; fairly clean; construction good, but ceilings of wood or iron in some rooms; lighting, ventilation, draining, and inside fittings excellent, and in good order. Cleansed and searched by large staff of employees under direction of Departmental officers, Sunday, 21st June.

Rats.—At residence, no signs; said none had been seen, but mice some weeks before, driven away by cats procured for that purpose. At the box-factory it was admitted a few rats were present; there was plenty of harbourage for them; but on examination it appeared that great care was really taken to avoid attracting them, and there was no sign of infestation; notices forbidding scattering of broken food were found posted, and proper boxes for it provided. At employment all agreed that no rats had been seen since 1902 (but see patient's statement, corroborated by fellow-apprentice); no signs of infestation; one rat-skeleton found, only; ceiling-spaces free; openings in basement walls afforded entry for outside rats.

Contacts and further Cases.—At residence, 4; at employment, 48. No further case at either place.

20. It will be noticed on the one hand that no direct connection with plague-rats was established in this case; but, on the other, that the circumstances appeared to exclude every other source of infection as well. In other words, it is manifest that some circumstance has remained undiscovered which was of determinative character in relation to attack.

21. The second case occurred a fortnight later.

CASE B.

Summary.—R.H., m., æt. 20, unmarried, master-tinsmith. No former attack; not inoculated; had had no communication with the previous case. Residence, Summer Hill, a suburb distant about 4 miles westerly from his place of employment, which was at 125, Sussex-street, Darling Harbour. Notified by Dr. Lawes, 4th July, afternoon; visited by the Assistant Medical Officer of the Government (Dr. R. J. Millard, M.B., D.P.H.), at Summer Hill, 2 p.m.; admitted to hospital 5th July, morning, discharged 5th August; duration of illness, 35 days. Right femoral bubo; morphological and cultural tests positive.

Movements prior to Attack.—Had regularly attended at his workshop for long before his attack; his business caused him to visit many shops and warehouses which stood in Sussex-street, and elsewhere in that neighbourhood; lunched daily at a place in Erskine-street, two doors from Sussex-street; 27th June attended a football match; and on the 28th visited the Coast Hospital to see a workman suffering from typhoid fever, who lay in a ward half-a-mile from the Infectious Diseases Division, in which Case A then was.

History of Illness.—2nd July, felt out of sorts on rising; went to the workshop as usual, and remained till evening, but felt very ill, shivered, and vomited several times; 3rd July, evening, first felt a pain in right groin; 4th July, afternoon, was found in bed, looked ill, headache, photophobia, T. 102·4, P. 84, dicrotic; right femoral bubo not larger than a hazel nut, some periadenitic effusion, very tender. No wounds of leg or foot, but many faint marks which may be flea-bites.

Residence.—Brick-built, two storeys, detached, clean, comfortable, connected with sewers; in all respects in good order. Two rooms occupied by patient were disinfected 5th July.

Employment.—Nos. 123–5–7 Sussex-street are contained within the same external rubble wall, and are very old. Two storeys show above street-level, two storeys below it open at rear to wharf-level. Basement, concrete floor, is a bonded store; next above is a produce store; Sussex-street, or ground-floor, occupied by offices and patient's large workshop; upper floor, a printer's. There were ceilings, and some double matched-board partitions. Premises fairly clean. A gang of twenty men was put in by the Local Authority for the City under the Senior Medical Officer of Health, Metropolitan District, 6th July.

Rats.—Residence was free from any sign of infestation. At patient's place of employment carcases of rats and mice were discovered as follows:—Basement, 9 rats, 1 mouse; upper basement, 1 rat, 5 mice; ground-floor (in part occupied by patient), 3 rats; in a wing at rear, 4 rats; 18 live mice were also caught. The carcases were putrid: the live mice were healthy; but on July 8th a mouse and a rat infected with plague were taken at No. 123, which building was one with No. 125; and on 9th July, 3 rats and 7 mice infected with plague were taken at No. 129, next door to the building which contained Nos. 123 to 127. There is no reason, therefore, for doubting that the unusual mortality discovered at No. 125 had been caused by plague.

Contacts and further Cases.—At residence, 4; at workshop, 4. No further case at either place.

22. In this instance direct connection with rats affected by disease was clear, although plague was not identified in any of the carcases because they were delivered in too putrid a state; two of them were found on the roof of a little glass-enclosed office which was erected in one corner of the large workshop. But on 8th July plague was identified in a rat and in a mouse taken at No. 125, which, as explained above, was structurally the same building as No. 123.

23. A third case of plague came to notice, which occurred on a coasting steamer; the place of infection could not be certainly indicated, but as the balance of evidence pointed strongly to Brisbane, it has not been debited to Sydney. However, the following are the facts:—

CASE

Case on the s.s. "Innamincka."

On 5th September, the Commissioner of Public Health, Queensland (Dr. B. Burnett Ham, M.D., D.P.H.), notified detection of a case of plague in a seaman on board the Adelaide Steamship Company's "Innamincka," at Townsville. He further said that the diagnosis had been established by the Government Bacteriologist (Mr. C. J. Pound), who had reported that the morphological, cultural, and inoculation tests applied to liquid extracted from the swollen right inguinal gland which the patient exhibited had all yielded positive results.

The "Innamincka" was a coasting steamer of 2,500 tons, trading between Sydney and Melbourne to the south, and between Sydney and North Queensland ports to the north; the round trip usually extended from Melbourne to Cairns, Queensland, the port of Sydney being entered on both northern and southern voyages. It occupied about 28 days.

A.H.D., æt. 26, A.B., had sailed in the "Innamincka" for eighteen months before his death. The ship's master and chief mate considered him the most trustworthy member of the crew. He was perfectly steady, and neither smoked nor drank. He was married; his wife and child lived at Drummoyne, a suburb of Sydney. His wife was questioned; she said he always went straight home after his work while the vessel was in port, and as far as she knew he had not visited any other house than his own during the ship's last stay; she last saw him when he left home on the morning of 29th August; he was then perfectly well; he had no wounds about the body. She showed a letter from him which was posted at Brisbane on 31st August, in which he said he was "in the best health." On return of the vessel to Sydney it was learned that A.H.D. had gone ashore at Brisbane on the evening of the 31st August; he was met, returning to the ship, by the carpenter, who asked him where he had been, and was told "to post a letter, and to buy a newspaper and some prawns,' which latter he was eating at the time. The vessel left Brisbane on 1st September at 3 p.m. On 3rd September he was at the wheel at 3 a.m., when he complained of feeling ill, was relieved, and went below. The "Innamincka" went alongside at Townsville, Queensland, early on 4th September; the patient was removed to hospital at 9·30 a.m., where he died at some time on 6th September.

The "Innamincka," after her previous voyage, had arrived at Sydney from Queensland ports on 20th August, at 6 a.m.; had berthed at Grafton Wharf, Darling Harbour; had visited the Colonial Sugar Company's Wharf, at Pyrmont, and had sailed for Melbourne on 21st August, at 6 p.m. She returned from Melbourne, and arrived at Sydney 27th August; berthed at Grafton Wharf; left Grafton Wharf for Queensland ports on 29th August, at 1 p.m. She again reached Sydney on her return voyage from Queensland, on 17th September, at 2 p.m. On arrival the vessel was arrested for inspection, but was allowed to go alongside immediately afterwards, no further illness having occurred on board. Rat-catchers were sent on board, and, notwithstanding reported fumigations for destruction of rats at Townsville and Cairns, Queensland, they delivered fourteen at the laboratory, all of which were healthy.

At Sydney the first plague-rat detected in 1903 was identified on 12th May; the last on 15th August. The "Innamincka" always lay at Grafton Wharf, which is one of 15 situated between the Gas-works and Erskine-street, on the eastern side of Darling Harbour. The records of work done by the Departmental rat-staff showed that these 15 wharves had been visited 149 times during August, 1903; 63 rodents had been caught at them and subsequently examined in the laboratory, all of which were healthy except a rat taken at Huddart Parker's goods wharf on 6th August, and a mouse taken at the same place on 11th August; these had plague. This wharf lay rather less than 300 yards south of Grafton Wharf. Special attention was directed to Grafton Wharf and the bonds connected therewith for a time after notification of A.H.D.'s case; visits were paid to it on 6th, 8th, 9th, 10th, 11th, and 13th September, when 22 rats and 31 mice were taken and examined in the laboratory, all of which were healthy. No plague-infected rodents were discovered later than 15th August (at a place remote from this wharf) either in this neighbourhood or anywhere else in Sydney, although the regular search along the wharf-lines continued.

As regards Brisbane, the Commissioner for Public Health has been good enough to inform me that the last case of the 1903 outbreak had been notified on 23rd May, and the last plague-rat had been identified on 8th June; between the latter date and 11th September (95 days) 3,424 rats and two mice had been examined by the Government Bacteriologist, and none had been found infected. But on 11th September 2 cases of plague were notified, and on 26th September 2 plague-rats were identified, all in central parts of Brisbane. From these facts it may be inferred that Brisbane was probably infected in its rats at the time at which A.H.D. landed there, namely, 31st August, on his last voyage.

Three sources of infection lay open to the patient, therefore; these were Sydney wharves, the vessel itself, and Brisbane. Melbourne wharves were under no sort of suspicion then or later, and may be safely excluded. Nothing at any time appeared pointing to infectiveness of the vessel, so that choice lay between Sydney and Brisbane. At what time was the patient infected? From his having been obliged by his illness to leave his post at the end of the third hour of the middle watch on 3rd September, it may, perhaps, be inferred that he was then attacked, or, at all events, that his attack probably began during that watch—say at midnight. He had left Sydney at 1 p.m., 29th August; that was the latest moment at which he could have been infected there. The interval between his *arrival* at Sydney on this voyage and the time of his attack was about 156 hours, and from the time he *left* Sydney it was 108 hours. From the time of his *arrival* at Brisbane to the hour of his attack was 59 hours, and from the time he *left* Brisbane it was 35 hours. In a case of bubonic plague the period of incubation is very unlikely to exceed 72 hours, and most often it is considerably shorter; yet, as it sometimes extends to 96 hours, and perhaps even somewhat longer, although it has been thought to have done so only in very rare cases which, as a matter of observation, are of doubtful validity, the possibility of his having been infected at Sydney cannot be positively excluded on that ground.

While the general search, and the abovementioned special searches, failed to detect any plague-infected rodent after 11th August at the line of wharves of which Grafton Wharf was one, or at any other part of Sydney after 15th August, subsequent events showed that the infection may well have been present in Brisbane many days before the two cases in man were notified on 11th September. A decision as to the place at which A.H.D. was infected is, of course, not possible; but, in my opinion, the balance of reasonable probability inclines to Brisbane.

24. During the epizoötic term, plague-rats were discovered on a vessel alongside, which had arrived from Buenos Ayres; and, as this was the second vessel (only) on which plague-rats have been observed during the four years 1900-3, the following account is placed on record:—

THE BARQUE "ALSTERSCHWAN."

On 18th September, the barque "Alsterschwan" 2,500 tons, left Tacoma, Washington, with a full cargo of wheat, and arrived at Callao, December 14th, 1902. She discharged, took in ballast, and sailed for Buenos Ayres, 4th March, 1903. She arrived at Buenos Ayres 15th April, and anchored in the stream; the Master alone went ashore. Sailed for Rosario, 17th April, arrived 20th; lay in the stream, discharged ballast into punts, and took in a full cargo of maize by means of chutes resting on a cliff about 60 feet high, below which the vessel lay, and left Rosario 17th May. 1st June, she came to an anchor 20 miles off Buenos Ayres, and the same day sailed for Sydney. Arrived Sydney, 29th July, and was reported by the Port Health Officer (Dr. C. W. Reid) as follows:—Crew 26, no passengers; clean bill, good health, good sanitary state; full cargo of maize in bags.

On 29th July, the "Alsterschwan" anchored in the stream for two or three days, awaiting a berth, and then went alongside at Darling Island. On 3rd August, one of the crew offered 112 rats at the public depôt; this occurrence was at once reported to the Department. On inquiry into the circumstances, the Master said that the rats had been found dead near the ventilators as soon as the hatches began to be removed; and he added that, with some idea of saving the cargo, the holds had been closed much more carefully than usual, and so as to prevent entrance of air as much as possible. To this he ascribed the mortality.

The rat-catchers were directed to secure further specimens, and on 4th, 5th, 6th, and 7th August delivered 1, 9, 25, and 16 rats, all of which were examined in the laboratory; 2, of the 16, were found to be infected with plague. Further numbers were delivered on 8th and 11th August (the latter after fumigation), among which were 6 and 3 infected carcases.

Immediately after receipt of report from the laboratory, the Master was directed to hoist the yellow flag, and to haul off into the stream, while landed cargo was arrested. Instructions were given for fumigating the vessel with the Clayton Apparatus on two successive days, with an interval between the two fumigations of not less than twelve hours. This was done on August 8th and 9th, the engine having been reported by the Chief Sanitary Inspector to have worked on the first day from 9·30 a.m. to noon, when tests showed 20 per cent. gas in the holds; all was then securely closed down, and not reopened till 6 a.m. on the second day. The second fumigation began at 10·30, 9th August, and afterwards the hatches were again left closed till 10th August. After aeration the vessel was allowed to go alongside again, and to resume discharging under supervision. No live rats were seen.

The vessel was under orders to proceed to Newcastle after discharging at Sydney, there to take in a cargo of coal. She carried no ballast, and relied for stiffening on about 650 tons of maize which were consigned to Newcastle. To have caused her to discharge this also at Sydney (as was desired in order to search for and remove all carcases of rats) would have obliged her to take in 500 tons of coal instead by way of ballast. The course usually taken under similar circumstances with produce-stores, warehouses, &c., ashore was directed: this portion of the cargo was turned over under supervision of Departmental inspectors; faulty bags were emptied and their contents replaced in new bags. This, and a general cleansing and search, occupied about five days, during which the vessel was hauled off from the quay. 117 carcases were discovered in various parts of the vessel, and no live animal was observed. Thereupon the ship was released, and sailed for Newcastle.

Part of the cargo, landed before detection of plague, had passed to consignees and was not interfered with. Part still on the quay was turned over, and new bags were substituted for faulty bags. No aeration or disinfection of bags or grain was done, and distribution of the cargo was not interfered with further. As appears elsewhere, the last plague-rat of this outbreak was taken 15th August, in a far removed lane of the city, to which it could not have reached from the quay at which the "Alsterschwan" lay.

Darling Island (so-called, *see* Diagram), where this vessel lay, is faced with concrete blocks, and comprises an area of several acres which carries many large sheds; it is traversed by many railway lines. Owing to the general construction of these yards, and to the persistent attention of the Railway Commissioners, rats have always been few here. No plague-rat has at any time ever been taken on the Island, and the nearest point at which any have been collected was in Pyrmont, in a street at a considerable distance from it, and on 13th July, 1902. No plague-rats have been observed either at the Island or in Pyrmont during the two years which at this present date have since elapsed.

The only information at command concerning plague at ports of South America touched by the "Alsterschwan" on this voyage is contained in the reports issued by the Public Health and Marine Hospital Service of the United States, from which it appears that eight cases were noted on 14th April at Buenos Ayres, while the s.s. "Duca di Galliera" was reported under date 23rd June to have arrived at Genoa with two cases of plague, and at Barcelona with one case, on board, and in July the s.s. "Espagne" was found on arrival at Marseilles to have plague on board, both vessels having taken their departure from Buenos Ayres.*

The "Alsterschwan" is the second vessel on which plague-rats have been detected in Sydney.

25. The large number of rats and mice caught at Gray's stables, and the length of time during which they continued to be found, have already been referred to above as requiring explanation. The circumstances were as follows:—

GRAY'S STABLES, WATERLOO.

The stables were situated on the margin of a populous neighbourhood, 2 miles from the focus in a direct line, and on a part of an area of blown sand rather sparsely occupied by factories. A varying number of horses were housed there, but usually about 100. The buildings, which comprised stables, sheds, feed-stores, and offices, were numerous, and the area occupied by them measured more than 13,000 square feet; they were ill-constructed of wood and iron. They were in a discreditable and filthy state, and greatly infested with rats and mice, to which linings, flooring-planks laid on the sand, and layers of unremoved horse-dung of great thickness afforded harbourage. They were leased to an omnibus proprietor, and were in part sublet to a firm of carriers.

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* As regards an earlier date than this see "Sur les épidémies de peste bubonique à l'Assumption (Paraguay) et à Rosario (République Argentine)," par M. Leopoldo Uriarte.—Annales de l'Institut Pasteur, 1901, p. 857.

In 1902 a plague-rat was taken on 26th April; and on 11th May one of the average number of forty men employed was attacked with plague. From that date onwards efforts were steadily made to cause the Local Authority to compel the tenants to reconstruct these stables, and to place them in reasonably good sanitary state; but the lease was to expire in a few months, and the granting of a new lease was then delayed by death of the owner. Hence, as the general epizoötic had ceased almost concurrently with cleansing of the premises from infection, a delay was allowed which, as it turned out, became protracted until the further occurrence of plague now being described.

In 1903 the first plague-rat was taken here on 15th June. The premises continued to yield plague-rodents for the next 36 days, a total of 64 infected rats and of 14 infected mice having been gradually collected during that term, notwithstanding that the general cleansing of the place had been completed in about a fortnight. The reason lay in the local conditions. Some of the rodents nested in the cover which was afforded by linings and so-called "floors," or in the sand underneath the latter; these were easily turned out. But the whole area presented burrows at many different points, and especially over a rather large tract of it which, it was found, had at some earlier date been the site of a garbage tip. Hence the search was at once difficult to complete and very laborious; and although the last plague-rodent was discovered on 20th June, the rats infesting the place were by no means then exhausted, but continued to be captured from time to time during several weeks thereafter in which watch was kept upon them.

The manner in which infected carcases made appearance is shown in the following Table:—

Date.	No. examined.		No. infected.		Date.	No. examined.		No. infected.	
	Rats.	Mice.	Rats.	Mice.		Rats.	Mice.	Rats.	Mice.
15 June, 1903 ...	12	...	11	...	9 July, 1903 ...	...	2	...	...
16 ,, ,, ...	6	...	3	...	10 ,, ,, ...	...	1	...	...
16 ,, ,, ...	9	1	3	...	13 ,, ,, ...	...	1	...	...
16 ,, ,, ...	15	1	12	...	14 ,, ,, ...	...	1	...	...
17 ,, ,, ...	1	3	...	...	15 ,, ,, ...	...	3	...	...
17 ,, ,, ...	16	6	10	...	16 ,, ,, ...	...	2	...	1
18 ,, ,, ...	3	5	1	...	18 ,, ,, ...	...	2	...	...
18 ,, ,, ...	17	1	10	1	20 ,, ,, ...	...	2	...	1
19 ,, ,, ...	5	...	3	...	21 ,, ,, ...	...	2	...	...
19 ,, ,, ...	25	3	10	...	22 ,, ,, ...	...	1	...	...
20 ,, ,, ...	3	2	...	...	24 ,, ,, ...	...	2	...	...
20 ,, ,, ...	13	4	...	...	30 ,, ,, ...	2	...	...	...
20 ,, ,, ...	2	1	...	...	7 August, ,, ...	1	1	...	...
22 ,, ,, ...	7	...	1	...	10 ,, ,, ...	...	2	...	...
23 ,, ,, ...	2	...	...	...	11 ,, ,, ...	1	2	...	...
23 ,, ,, ...	4	8	...	2	12 ,, ,, ...	1	1	...	...
24 ,, ,, ...	2	4	...	3	13 ,, ,, ...	...	2	...	...
24 ,, ,, ...	2	1	...	...	14 ,, ,, ...	...	2	...	...
25 ,, ,, ...	1	3	...	1	15 ,, ,, ...	1	1	...	...
26 ,, ,, ...	...	3	...	1	17 ,, ,, ...	1	...	...	...
27 ,, ,, ...	2	1	...	1	18 ,, ,, ...	1	...	...	...
29 ,, ,, ...	1	6	...	...	22 ,, ,, ...	...	1	...	...
30 ,, ,, ...	2	1	...	1	24 ,, ,, ...	1	...	...	...
1 July, ,, ...	..	6	...	1	26 ,, ,, ...	2	1	...	...
3 ,, ,, ...	...	2	...	...	27 ,, ,, ...	2	...	...	...
4 ,, ,, ...	...	2	...	...	28 ,, ,, ...	1	1	...	...
6 ,, ,, ...	...	2	..	...	31 ,, ,, ...	2	...	...	...
7 ,, ,, ...	...	1	...	...					
8 ,, ,, ...	...	1	...	1	Grand total ...	166	101	64	14

Plague-rats continued to be found during 14 days only; and of 134 carcases submitted during this term only 64, or a minority, were infected. Plague-mice were found during 25 days; but of the 66 submitted only 14 were infected. During forty days subsequent to observation of the last plague-rat, 32 healthy rats were brought in; and during nineteen days after discovery of the last plague-mouse 19 healthy mice were submitted. Rats eat mice as well as each other.

No person took the infection at these stables in 1903. General information furnished by the intelligence staff before 15th June, and concentration of that staff in the neighbourhood subsequent thereto, showed that the latter was free from infection; and there is no room for reasonable doubt that it was conveyed *per saltum* to the stables from the focus at Darling Harbour, although the proprietors could not say more as to origin of their supplies of feed than that they purchased in lots as favourable opportunities offered, and of any dealer in Sussex-street whose terms suited them. However, some slight evidence of its spread to the contiguous land and the buildings on it was gained by discovery of a single plague-rat at a soap-works near the stables on 23rd June, and on inhabited premises in a street at a rather greater distance away (and in another direction) on 24th June; but further search rendered it probable that these animals were but strays, fortunately detected before they had had time to become a source of the disease to any horde which they may have joined. The omnibus service was transferred to other premises; the omnibuses were not interfered with.

After this second outbreak the premises were given up, and new stables were erected elsewhere.

26. Analysis of the records relating to discovery of infected rodents on the 23 remaining premises shows that 15 of them yielded plague-rats on a single day, namely, the day of discovery and of report; 14 of them also yielded but a single specimen. The other, which was a large factory where spices, rice, maize, mustard, &c., were manufactured or packed, yielded 4 on the one day, and no more were found during the several subsequent days over which the search extended. Of these 15 places 6 were wharves or piers, 2 were pieces of vacant land, 2 were streets or lanes. Of the other five, one was another factory for oatmeal, maize, &c., one was a soap-works (Waterloo, see above), and 3 were produce stores on the water side of Sussex-street.

27. The eight places from which plague-rodents were collected on more than one day yielded them during terms which extended to 2, 4, 12, 16, and 52 days. Seven of them were produce stores, situated on the water side of Sussex-street; the eighth was a wharf abutting on that street. The tables which are printed in Appendix A show the dates on which plague rodents made appearance among the healthy carcases. They are not complete as regards the after term, but no more infected carcases were taken. In the lastmentioned case (52 days) a long interval of 47 days, during which 11 plague-free rats and 36 plague-free mice were taken on 14 days, pointed to reinfection of the premises.

28. The two patients were lodged in one half of a small ward in the Infectious Diseases Division of the Coast Hospital, of which the other half continued to be occupied by persons suffering from other forms of disease. The rooms in which they had lain ill at home were disinfected in usual ways as a measure of precaution, although our uniform experience has been that such patients never communicate infection to their surroundings. Contacts were examined and recorded, but were not afterwards interfered with in any way.

29. It will have been perceived that the details mentioned in this account are fuller and still more nearly complete than those which were given in the corresponding histories of the outbreaks of 1900 and 1902, while the former exactness has been maintained. This is to be ascribed in part to the results of teaching and experience on the numerous members of the inferior staff, and, indeed, in some measure on the general public; but little advance in knowledge of many of the phenomena of plague in this city could be made without their intelligent co-operation. But all concerned in practical management have greatly benefited by further reflection and wider experience. Consequently, plans were laid on this last occasion with more assured confidence, directions were given with greater precision, and both were more completely carried out than ever before; while superfluous effort, the cause of unnecessary expenditure, was completely restrained.

J. ASHBURTON THOMPSON.

APPENDIX A.

APPENDIX A.

TABLES showing the way in which Plague rodents appeared among rodents captured on infected premises from which plague-infected rodents were taken on more than one day.

153, Sussex-street.				
Date.	No. examined.		No. infected.	
	Rats.	Mice.	Rats	Mice.
1903.				
9 May ...	1	...	...	...
11 „ ...	1	...	...	...
12 „ ...	3	...	1	...
13 „ ...	4	11	2	...
14 „ ...	1	...	...	...
16 „ ...	2	...	...	...
....	...	...	...	...
....	...	...	...	...
....	...	...	...	...
....	...	...	...	...
....	...	...	...	...
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....	...	...	...	...
....	...	...	...	...
....	...	...	...	...
....	...	...	...	...
....	...	...	...	...
Total ...	12	11	3	...

151, Sussex-street.				
Date.	No. examined.		No. infected.	
	Rats.	Mice	Rats.	Mice
1903.				
14 May ...	1	...	...	...
15 „ ...	2	...	2	...
16 „ ...	4	1	2	...
18 „ ...	1	...	...	...
21 „ ...	1	1	...	...
....	...	...	...	...
....	...	...	...	...
....	...	...	...	...
....	...	...	...	...
....	...	...	...	...
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....	...	...	...	...
....	...	...	...	...
....	...	...	...	...
....	...	...	...	...
....	...	...	...	...
....	...	...	...	...
....	9	2	4	...

139, Sussex-street.				
Date.	No. examined.		No. infected.	
	Rats	Mice.	Rats.	Mice
1903.				
15 May ...	1	...	...	...
15 „ ...	1	...	1	...
18 „ ...	2	1	...	1
18 „ ...	5	1	...	1
19 „ ...	3	...	...	...
....	...	...	...	...
....	...	...	...	...
....	...	...	...	...
....	...	...	...	...
....	...	...	...	...
....	...	...	...	...
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....	...	...	...	...
....	...	...	...	...
....	...	...	...	...
....	...	...	...	...
....	...	...	...	...
....	...	...	...	...
....	...	...	...	...
....	12	2	1	2

129, Sussex-street.				
Date.	No. examined.		No. infected.	
	Rats.	Mice.	Rats.	Mice.
1903.				
18 May ...	8	4	...	...
19 „ ...	2	1	1	...
18 June ...	...	7	...	...
19 „ ...	...	4	...	...
20 „ ...	1	4	...	...
22 „ ...	2	2	...	...
23 „ ...	...	3	...	...
24 „ ...	...	5	...	...
25 „ ...	...	3	...	...
26 „ ...	...	2	...	...
27 „ ...	...	1	...	...
29 „ ...	1	...	...	...
30 „ ...	...	1	...	...
1 July ...	2	1	...	...
2 „ ...	1	...	...	...
4 „ ...	4	3	...	...
6 „ ...	...	1	...	1
7 „ ...	...	1	...	1
9 „ ...	3	10	1	5
10 „ ...	...	4	...	...
13 „ ...	...	1	...	...
17 August ...	...	2	...	...
18 „ ...	...	1	...	...
19 „ ...	...	1	...	...
21 „ ...	...	1	...	...
22 „ ...	2	1	...	...
24 „ ...	...	1	...	...
25 „ ...	...	1	...	...
....	26	66	2	7

101, Sussex-street.				
Date.	No. examined.		No. infected.	
	Rats.	Mice.	Rats.	Mice.
1903.				
1 May ...	1	2	...	...
1 „ ...	...	1	...	1
	Cat.			
2 „ ...	1	1	...	1
	Rats.			
2 „ ...	1	...	...	...
3 „ ...	1	4	...	1
5 „ ...	...	3	...	2
6 „ ...	1	4	...	1
6 „ ...	...	4	...	1
7 „ ...	...	3	...	2
7 „ ...	...	8	...	...
8 „ ...	...	4	...	1
9 „ ...	...	7	...	2
0 „ ...	...	16	...	...
1 June ...	...	8	...	...
1 „ ..	...	4	...	1
2 „ ...	...	2	...	...
....	...	...	...	...
....	...	...	...	...
....	...	...	...	...
....	...	...	...	...
....	...	...	...	...
....	...	...	...	...
....	...	...	...	...
....	...	...	...	...
Total ...	5	71	...	13

137, Sussex-street.				
Date.	No. examined.		No. infected.	
	Rats.	Mice.	Rats.	Mice.
1903.				
15 May ...	10	5	...	...
18 „ ...	1	17	...	...
18 „ ...	23	4	...	...
18 „ ...	8	20	...	...
18 „ ...	15	6	...	...
19 „ ...	1	1	...	...
20 „ ...	9	...	...	...
25 „ ...	...	1	...	...
26 „ ...	1	...	...	...
27 „ ...	1	...	...	...
5 June ...	3	1	...	...
6 „ ...	3	1	...	...
9 „ ...	2	...	...	...
10 „ ...	1	1	1	...
11 „ ...	1	...	...	...
15 „ ...	1	...	1	...
15 „ ...	15	7	2	...
16 „ ...	1	1	1	...
16 „ ...	7	4	6	...
17 „ ...	9	2	2	...
17 „ ...	3	3	...	...
18 „ ...	5	3	2	...
25 „ ...	...	2	...	1
29 „ ...	1	...	...	...
1 July ...	1	...	...	...
25 „ ...	...	7	...	...
....	122	86	15	1

123, Sussex-street.				
Date.	No. examined.		No. infected.	
	Rats.	Mice.	Rats.	Mice.
1903.				
16 May ...	2	...	...	...
19 „ ...	2	1	...	...
22 „ ...	2	...	...	...
23 „ ...	1	5	...	...
12 June ...	...	3	...	...
6 July ...	1	1	...	1
7 „ ...	1	2	...	2
8 „ ...	1	18	...	...
9 „ ...	...	2	...	...
....	...	...	...	...
....	...	...	...	...
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....	...	...	...	...
....	10	32	...	3

Huddart Parker's Wharf, Margaret-street.				
Date.	No. examined.		No. infected.	
	Rats.	Mice.	Rats.	Mice.
1903.				
6 Aug. ...	4	5	1	...
11 „ ...	...	2	...	1
....	...	...	...	...
....	...	...	...	...
....	...	...	...	...
....	...	...	...	...
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....	...	...	...	...
....	...	...	...	...
....	...	...	...	...
....	4	7	1	1

APPENDIX B.

APPENDIX B.

[Form No. 312.]

DEPARTMENT OF PUBLIC HEALTH, NEW SOUTH WALES.

"MUNICIPALITIES ACT, 1897."

MODEL By-laws under section 130 (xxii) for better prevention of the spread of Plague by Rats; for regulating the construction and maintenance of Stables, Produce Stores, &c., &c.; and for storage and collection of House Refuse and Garbage.

(As passed by the Attorney General, 2nd July, 1903.)

---

1. The owner of any produce store in the Municipality, the floors of which are of such material, or so constructed, or in such a state as to permit the harbouring of rats in or about such store, shall, within one month after service upon him of a notice purporting to be signed by the Inspector of Nuisances requiring him so to do, cause such floors to be so reconstructed of concrete, stone, or other material impervious to rats, and shall so repair, alter, reconstruct or protect skirting-boards, partitions, doors, ventilation or other openings in the walls or elsewhere of such produce store, as to prevent, as far as practicable, access of rats to and harbourage of rats in or about it.

2. The owner of any premises within the Municipality who, after the passing of these by-laws, shall construct or let any building therein for the purposes of a produce store, or who shall convert any building therein to the purposes of a produce store, shall upon such construction, letting, or conversion, as the case may be, cause the floors thereof to be constructed of concrete, stone, or of other material impervious to rats, and he shall so construct, alter, repair, reconstruct or protect skirting-boards, partitions, doors, ventilation or other openings in the walls or elsewhere, as to prevent, as far as practicable, access of rats to and harbourage of rats in or about such premises.

3. The owner of any building, other than a produce store in the Municipality, which is in such a condition as to permit the access of rats to, or the harbourage of rats in it, and whether such condition be in the structure, or in openings in it, or in doors or ways of entrance to it, or in its floors, skirting-boards, ceilings, partitions, or the like internal fittings within it, shall, within one month after service upon him of a notice purporting to be signed by the Inspector of Nuisances requiring him so to do, cause such building to be so repaired, or as regards its doors or ways of entrance and its floors, skirting-boards ceilings, partitions, and the like internal fittings within it, to be so altered or repaired, as to prevent, as far as practicable, access of rats to it and harbourage of rats within it.

4. The owner of any premises within the Municipality with which is connected any area grating, or in the external walls of which is any other opening of such a nature as to permit the entry of rats thereto, shall, within fourteen days of service upon him of a notice purporting to be signed by the Inspector of Nuisances requiring him so to do, cause such area grating and such other openings to be covered with wire netting of such a mesh and in such a manner as to prevent the entry of rats through them.

5. The owner of any stable, cow-yard, or cattle-shed, within the Municipality now constructed, shall cause the same to be paved, flagged or floored with concrete, stone, or other material impervious to rats, and to be completely and well drained, and to have proper sewer connections where available, within one month after service upon him of a notice purporting to bo signed by the Inspector of Nuisances requiring him so to do.

6. The occupier of such premises shall, upon production of the notice served upon the owner as aforesaid, allow the owner and his workmen free access thereto for the purpose of enabling him and them to comply with the terms of the preceding by-laws.

7. The owner of any premises within the Municipality who shall, after the passing of these by-laws, construct a stable, cow-yard, cattle-shed, or pig-sty therein, or convert any building therein into a stable, cow-yard, cattle-shed, or pig-sty, shall cause the same to be paved, flagged, or floored with concrete or stone, or other approved material impervious to rats, to be completely and well drained, and to have proper sewer connections where available.

8. The owner or occupier of any stable, cow-yard, cattle-shed, or pig-sty within the Municipality shall, within one month of service upon him of a notice purporting to be signed by the Inspector of Nuisances requiring him so to do, cause any feed-store connected with such stable, cow-yard, cattle-shed, or pig-sty to be floored with concrete, stone, or other material impervious to rats, and shall so reconstruct, repair, or alter any floor, wall, and any ceiling or partition within it as may be directed so as to prevent the harbourage of rats therein, and shall protect all openings in the external walls thereof as may be directed so as to prevent the access of rats thereto.

9. The occupier of any premises in the Municipality which contain any stable, cow-yard, cattle-shed or pig-sty shall provide a bin for the reception of all dung or refuse arising in such stable, cow-yard, cattle-shed, or pig-sty, and shall cause such stable, cow-yard, cattle-shed, or pig-sty to be cleansed daily; and all manure, dung or other refuse arising in or in connection therewith if not removed from the premises immediately to be placed in such bin, and shall cause the said bin to be kept covered, and to be emptied and cleansed and its contents to be removed from the premises at least once in every week, and shall not at any time allow such bin to be or to remain a nuisance.

10. No person shall place or throw or suffer to remain any refuse on any premises in the Municipality in such a manner or for such a time as to encourage rats or other vermin to visit or frequent such premises.

11. Every occupier of premises in the Municipality shall, within seven days of service upon him of a notice purporting to be signed by the Inspector of Nuisances for the Municipality requiring him so to do, provide a sufficient number of receptacles of rigid metal, cylindrical in shape, and each of a capacity not exceeding 2 cubic feet for the reception of the garbage and refuse arising upon such premises.

12. Every such occupier shall provide all refuse and garbage receptacles in use on such premises with a cover, fitting as closely as practicable, and shall cause such receptacles to be continuously covered, save when garbage or refuse is being deposited in or discharged from them.

13. Every such occupier shall cause all refuse or garbage receptacles in use on his premises and the covers thereof to be kept as clean as practicable, and maintained in good order and condition, and shall cause all garbage and refuse from time to time arising upon such premises to be forthwith deposited in such receptacles.

14. Every such occupier between such hours and on such days as may be prescribed by notice served upon him, and purporting to be signed by the Inspector of Nuisances, shall cause such receptacles to be placed in such a position on such premises as to be within 6 feet of the gateway or entrance from the street abutting on such premises, which is traversed by any vehicle employed by the Council in the collection of garbage and refuse, and so as to be conveniently accessible to the persons employed by the Council in the removal of garbage and refuse. Provided that if, by reason of conformation of the premises, it shall not be practicable to comply with the requirements of this by-law, and such occupier shall cause such receptacles to be placed on the outer edge of the footway in such street between the hours and days as aforesaid, he shall not be guilty of an offence against this by-law.

15. No person other than a workman employed by the Council in the collection of garbage and in street-cleansing shall interfere with, disturb, or remove any garbage receptacle for the time being in any street, nor the contents of any such receptacle.

16. The owner of any premises within the Municipality shall, within one month of service of a written notice purporting to be signed by the Inspector of Nuisances, cause the floor of any water-closet and of any pail-closet situated wholly or in part outside the walls of the dwelling portion of the premises, to be constructed of good cement concrete not less than four inches in thickness, and to be so laid that it shall be in every part thereof at a height of not less than six inches above the level of the ground adjoining such closet, and so that the said floor may have a fall or inclination from the rear of the closet towards the door of entrance of not less than one-half inch to the foot, and the riser enclosing the space beneath the seat (if any) to be removed in the case of a water-closet, and in the case of a pail-closet to be well fitted to the seat and to extend downwards not more than four inches from the under side of the seat.

17. In construction of these by-laws the words "produce store" shall mean any building or portion of a building wherein wheat, oats, barley, maize, pollard, bran, hay, lucerne, or chaff is deposited or exposed for sale, and with regard to other words, a similar construction shall be applied as the Interpretation Act, No. 4, 1897, provides for the interpretation of Acts of Parliament.

18. Any person offending against any of the above by-laws shall for each offence, upon conviction, forfeit and pay a sum not exceeding £10.

By order,
G. H. KING,
Secretary.

Sydney, 22nd July, 1903.

In the Metropolitan District the following Municipal Councils voluntarily adopted these by-laws:—

Alexandria.
Annandale.
Ashfield.
Balmain.
Burwood.
Canterbury.
Concord.
Enfield.
Granville.
Hurstville.
Leichhardt.
Manly.
Mosman.
North Sydney.
Parramatta.
Petersham.
Randwick.
Rockdale.
Vaucluse.
Waterloo.
Willoughby.

The by-laws were ultimately imposed (see Public Health Act, section 25) on the following:—

Bankstown.
Botany.
Camperdown.
Darlington.
Drummoyne.
Ermington and Rydalmere.
Erskineville.
Glebe.
Hunter's Hill.
Kogarah.
Lane Cove.
Marrickville.
Marsfield.
Newtown.
North Botany.
Paddington.
Redfern.
Rookwood.
Ryde.
St. Peters.
Strathfield.
Waverley.
Woollahra.

[Diagram.]

Sydney: William Applegate Gullick, Government Printer.—1904.

N° of Lith. 04.1058 D

Table shewing the places at which, and the first and last dates on which, plague-rats were taken; the entries are consecutively numbered in accordance with the dates on which they were first taken. References to the two cases are inserted in the series in their order according to the date of attack, and these are not numbered.

N°	Place	Plague Rodents taken				First date	Last date
		M. Dec.	M. Rat.	M. Mus.	Total		
1	153 Sussex Street	3			3	12. 5. 03	13. 5. 03
2	151 Sussex Street	4			4	15. 5. 03	16. 5. 03
3	139 Sussex Street	1		2	3	15. 5. 03	18. 5. 03
4	129 Sussex Street	1	1	7	9	19. 5. 03	9. 7. 03
5	Dangar Gedye's Wharf, N° 1, W'loo	1			1	20. 5. 03	20. 5. 03
6	101 Sussex Street			14	14	21. 5. 03	1. 6. 03
7	150 Sussex Street			1	1	22. 5. 03	22. 5. 03
8	Long Pier, Woolloomooloo	1			1	28. 5. 03	28. 5. 03
9	137 Sussex Street	2	13	1	16	10. 6. 03	25. 6. 03
10	A.U.S.N. Wharf N° 1	1			1	13. 6. 03	13. 6. 03
11	Gray's Stables, Elizabeth Street, Waterloo	64		14	78	15. 6. 03	20. 7. 03
12	Town's Wharf	1			1	15. 6. 03	15. 6. 03
13	Dalgety's Wharf, New, N° 1	1			1	15. 6. 03	15. 6. 03
	Case A, attacked 17. 6. 03						
14	268 Kent Street			1	1	22. 6. 03	22. 6. 03
15	Hunter's Soap Works, Bourke Street, Waterloo	1			1	23. 6. 03	23. 6. 03
16	81 Kellick Street, Waterloo	1			1	24. 6. 03	24. 6. 03
	Case B, attacked 2. 7. 03						
17	123 Sussex Street			3	3	6. 7. 03	7. 7. 03
18	195 Sussex Street			1	1	8. 7. 03	8. 7. 03
19	259 Sussex Street	1			1	9. 7. 03	9. 7. 03
20	Vacant Lane, Off Lime Street	1			1	11. 7. 03	11. 7. 03
21	321-7 Kent Street			4	4	14. 7. 03	14. 7. 03
22	McQuade's Point, Potts Point	1			1	15. 7. 03	15. 7. 03
23	H Parker's Wharf, Margaret Street		1	1	2	6. 8. 03	11. 8. 03
24	Ship "Alsterschwan", Darling Island		11		11	7. 8. 03	11. 8. 03
25	Loftus Lane, Off Loftus Street	1			1	15. 8. 03	15. 8. 03
	Totals	86	26	49	161		

PREPARED FOR THE DEPARTMENT OF PUBLIC HEALTH

MAP OF THE

CITY OF SYDNEY

AND

ADJACENT MUNICIPALITIES.

THIS DIAGRAM SHEWS THE PLACES AT WHICH PLAGUE-RATS WERE TAKEN DURING 1903, THE PLACES AT WHICH TWO PERSONS WHO HAD PLAGUE WERE EMPLOYED AND THE PLACES AT WHICH THEY RESIDED.

EXPLANATORY NOTES

Places at which plague-rats were taken_consecutively numbered in accordance with the date on which the first was taken at each place	shewn thus	●22
Places at which 2 persons who had plague were employed	do.	A.B.
Do. do. do. do. resided	do.	ⓐⓑ
Boundaries of the Wards into which the City proper is divided	do.	- - - - - -

Compiled, Drawn and Printed at the Department of Lands, Sydney N.S.W. Decr 1904

J. Ashburton Thompson.
7th Dec: 1904.

Seamen's Hospital Society
TROPICAL
DISEASES
19 JUN. 1923
LIBRARY

1905.

LEGISLATIVE ASSEMBLY.
NEW SOUTH WALES.

REPORT

OF THE

BOARD OF HEALTH

ON A

FOURTH OUTBREAK OF PLAGUE AT SYDNEY,

1904;

With Remarks on the Aetiology of Plague, based on its observed Epidemiology, 1900-4.

BY

J. ASHBURTON THOMPSON, M.D., D.P.H., President,
Chief Medical Officer of the Government.

Printed under No. 7 Report from Printing Committee, 17 August, 1905.

SYDNEY: WILLIAM APPLEGATE GULLICK, GOVERNMENT PRINTER.

1905.

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With Remarks on the Aetiology of Plague based on its observed Epidemiology, 1900-4.

By J. ASHBURTON THOMPSON, M.D., D.P.H., President, Chief Medical Officer of the Government.

7 July, 1905.

ALTHOUGH it has been stated in each of the reports for 1900, 1902, and 1903, that, at Sydney, man has acquired the infection of plague from rats affected with that disease, the remark is here made once more in connection with further precise evidence now to be adduced. Epidemic plague at Sydney has always depended wholly and solely on epizoötic plague; and it has been successfully controlled there by measures directed, not at man, nor at the filth in which he sometimes lives, but at the rat alone. The manner in which the infection is communicated from rat to man is a subject of great practical importance; but it may, and in my opinion should, be separately examined. The hypothesis of the flea, notwithstanding much circumstantial evidence adduced first in this series of papers, has remained thus far insufficiently examined by direct experiment.

2. The plague-rat is the source of infection for man; to get rid of it is to stay the disease. The ground for that opinion has been described in detail in the three previous accounts, and with completeness; but it is possible that it has not appeared to be perfectly sound to some who may not have found themselves at liberty to examine it very closely. Should this have been so, some circumstances which may have been contributory to their doubt can be mentioned. Thus, the first report (November, 1900) was necessarily occupied in the main with examination of the commonly received view that plague becomes epidemic as the result of direct or indirect communication with the sick. On this point attention was at that time concentrated, for until the ground had been cleared by settling it conclusively nothing further could be done; and consequently, although the influence of plague-rats was watched at the same time, and so watched as to warrant those who actually observed the course of events in ascribing the principal rôle to them, evidence sufficient to establish this to the satisfaction of others was not then obtained. The inefficiency of that cause having been decisively established by the course of the epidemic of 1900, in 1902 the rôle of the rat preoccupied attention. It was so examined, and the results were so recorded in the report which related to that year, as to show its preponderating and, indeed, its exclusive importance. Still, the evidence, though full and cogent, was hardly of the kind which he who runs may read. I point out, therefore, as a second contributory circumstance, that reasonings in which defects in the evidence are given almost equal prominence with ascertained data are likely to confuse all but the critical reader; and this is the character which the preceding descriptions of plague at Sydney have had, for my object has been to draw a complete picture of all the known circumstances—a character which has not been so commonly shared by writings on the epidemiology of plague as to make reference to it in this place superfluous.

3. By 1903 the exclusive nature of the rôle played by the rat had come to be generally accepted by all in this State. We had not merely learned that but one thing was necessary to stay, and to prevent, epidemic plague, namely, to kill the

plague-rat, but also that the plague-rat could be searched out with sufficient completeness, difficult or even hopeless as this business may have seemed at first sight. Instructions, consequently, were simplified to the last degree. The business of getting them punctually observed, also, was facilitated by the thorough training which the staff had by that time received, and by the active and intelligent assistance which the public had been gradually brought to render willingly, even when it happened that their action was attended with expense to them, and with some less direct injury to their immediate personal interests. Leisure to inquire into the circumstances of each case, and into the condition of each building and neighbourhood, in the most complete and exact way thus became available, and for the first time it was possible to concentrate attention on an attempt to learn whether very close association with plague-rats could not be established in every case of plague, provided sufficient time were devoted to the investigation. But evidently the method of managing epidemic plague which had been adopted was inimical to this object, for just in as far as it was well grounded and thoroughly applied it was likely to prevent cases from occurring. In point of fact, it turned out in 1903 that although the epizoötic did smoulder for about three and a half months in spite of all that was done to extinguish it, it was so far successfully restricted by the method referred to that it never attained to considerable dimensions in any neighbourhood, and consequently gave rise only to two cases. That the completeness of this result was in part due to some favouring circumstance which has not been precisely identified is likely enough ; but, however that may be, two cases were insufficient for the purposes of the contemplated inquiry, and another opportunity was awaited. It arrived during the year under review, and it was utilised as described below. It will be found that the connection mentioned above between plague-rats and man was established in every instance.

4. The last evidence of presence of plague in Sydney connected with the preceding outbreak was got on 15th August, 1903, when the infection was identified in the carcase of a rat. The outbreak now to be described consisted in an epizoötic of plague of which the first direct evidence was got on 1st March, 1904, the last on 3rd December; thus it continued during 9 months. Its course was marked by occurrence of plague in 12 persons who inhabited 11 dwellings, of whom 6 died; the first case was notified 9th March, the last on 10th September, 1904, and these dates defined a period of a little over 6 months which fell within the time-limits of the epizoötic.

5. The term which it is necessary to review comprised rather more than 13 months, and may be divided as follows. The precedent plague-free period dated from 16th August, 1903, to 29th February, 1904; the epizoötic period from 1st March to 3rd December ; and the ensuing plague-free period from 4th to 31st December, 1904. It is as well to mention here that the latter turned out to be very short, but that recommencement of the epizoötic at Sydney (19th January, 1905, at the North Coast S.S. Company's Wharf) was thought to have resulted from reintroduction of the infection from a district on the northern coast-line of the State, which itself was probably infected by sea from another source than Sydney.

6. The way in which watch was kept on the state of the rat tribe during the three periods just mentioned, and in which the epizoötic was restricted during the second of them, were precisely the same as has already been described in detail (Report, 1903) ; the officers concerned were the same, they performed similar functions, and the result of the general operations was marked by a success which was as nearly the same as could be expected. Description of these details for 1904 would entail useless repetition and is omitted.

7. Now, as regards the precedent plague-free period, which dated from 16th August, 1903, to 29th February, 1904, the number of rats destroyed was 53,912, of mice, 24,249 ; total rodents destroyed, 78,161. Of these the public delivered 41,982 rats and 17,723 mice, total 59,705, for which they were paid. None of these were examined in the laboratory, for reasons already explained (Report, 1903, par. 7). The remainder were collected by the intelligence staff, namely, 11,930 rats and 6,526 mice ; total, 18,456. All of these were examined in the laboratory (at the rate, therefore, of about 110 a day), and all were found to be free from infection with plague. They had been collected on the wharf-line, which extended from the head of Darling Harbour to the eastern head of Woolloomooloo Bay, from stores and

buildings connected with it, and from some closely adjacent streets of the city, being localities in which experience had shown that recurrent plague was most likely first to show itself. Thus, on 28th February, 1904, it appeared probable that Sydney had been free from plague in its rats for more than six months, as it certainly had been free from plague in man.

8. During the second, or epizoötic, period which dated from 1st March to 3rd December, 1904, the number of rats destroyed was 61,657, of mice, 47,279; total, 108,936. Of these, 41,263 rats and 23,851 mice, total 65,114, were brought in by the public, and were paid for as above-mentioned. None of them were examined. The intelligence staff delivered 20,394 rats and 23,428 mice (total, 43,822), all of which were examined at the laboratory, at the rate of about 182 a day. Among them, 181 rats and 62 mice, total 243, were found to have had plague; the remainder were free from this infection. Additionally, 13 other animals were referred for examination, namely, 5 domestic cats, 1 opossum, 5 native-cats (*Dasyurus viverinus*, Shaw), 1 tiger-cat (*Dasyurus maculatus*, Kerr), and 1 sparrow (*Passer domesticus*). Plague was identified in 1 domestic cat, and this was the second in which this infection had been observed at Sydney (*see* Report, 1900, p. 39).

Besides the above-mentioned animals, the infection of plague has been identified at Sydney by Tidswell in the following, which had become exposed to it in a zoological garden :—4 wallabies, 1 wallaroo, 1 pademelon, and 1 tree-kangaroo (all of which are marsupials), in 1 Indian antelope, and in 3 caged guinea-pigs. As plague had not previously been observed in marsupials, the methods employed to discover and to discriminate the bacillus were of the highest importance; they were, therefore, described at length (Report, 1902, parts 157-163), although they differed not at all from those usually followed in this laboratory in connection with plague-work in general.

No other animals, and especially none of the farm-yard species, have fallen under suspicion of infection in this part of the world. Simpson and Hunter, working at Hongkong, have reported that various domestic animals (pigs, calves, fowls, turkeys, geese, ducks, pigeons, &c.) were infected experimentally by them, and that the pigs often survived for more than a month, during which they offered no evident sign of illness except an increased body temperature, although they died of plague at last. (Simpson: "Report to the Secretary of State for the Colonies on Plague at Hongkong," 1903, pp. 49-103.) The evidence adduced by the authors in support of their conclusions was meagre. Bacteriological methods and results, and the experimental conditions in general, were not adequately described, so that their statements amounted to little more than assertions, notwithstanding clinical accounts of the cases. Confirmation must, therefore, be awaited.

These experiments were repeated in Natal by Mr. H. Watkins-Pitchford, F.R.C.V.S., Government Bacteriologist, who reported upon them, and Dr. Haydon. ("Report on the Plague in Natal, 1902-3; by Ernest Hill, M.R.C.S., D.P.H., Health Officer for the Colony." Cassell & Co., London, 1904). The series of animals employed comprised 20 barn-yard fowls, 11 pigs, and 2 calves. The results were uniformly negative; plague was not communicated in any instance. The details were so completely given by Mr. Pitchford that little was left wanting.

9. During the third, or ensuing plague-free period, which dated from 4th December to 31st December, 1904, 5,435 rats and 2,796 mice, total 8,231, were destroyed. Of these, 3,504 rats, and 1,582 mice, total 5,086, were brought in by the public, and none of them were examined. The intelligence staff delivered 1,931 rats and 1,214 mice, total 3,145, all of which were examined at the laboratory, and all were found to be free from infection with plague.

10. The several species of rodents examined in the laboratory during the whole of the year 1904, and the proportions in which they occurred, can be stated. The total number was 52,014; 35·43 per cent. of them were *Mus decumanus*, 14·06 per cent. were *Mus rattus*, and 50·47 per cent. were *Mus musculus*.

11. The number examined during the epizoötic period alone was 43,822; 32·15 per cent. of them were *Mus decumanus*, 14·36 per cent. were *Mus rattus*, and 53·44 per cent. were *Mus musculus*.

12. Of those which were found to be infected with plague, 108 were *Mus decumanus*, 73 *Mus rattus*, and 62 *Mus musculus*, and these constituted respectively 44·26 per cent., 29·92 per cent., and 25·41 per cent., of the total (243) infected.

13. The percentage of each species infected to the total of each species examined during the epizoötic period was for *Mus decumanus* ·76, for *Mus rattus* 1·16, and for *Mus musculus* ·26; or, for all rats ·9, and for mice but ·26, although the number of mice examined (23,428) exceeded the number of both species of rats taken together (20,394.) As all these rodents were collected by the same staff, working on the same areas, perhaps some reason appears for supposing that mice may be less susceptible than rats to "natural," as they are to laboratory, plague. In connection with the small proportion of the infected to the total rodents examined during this period, remarks already made (Report, 1903, pars. 13 to 15) should be reperused.

14. The species of rodents found on the nine premises at which the twelve patients were adjudged to have received the infection were as follows:—Case A, *Mus musculus* (but rats had died in unusual number before notification of the case, and on search some carcases were found at a stage of putrefaction which was too far advanced for bacteriological examination); Case C, *M. decumanus*; Case I, *M. musculus* and *M. decumanus*; Cases B, E, and G, *M. musculus, decumanus,* and *rattus*; Cases, D, F, H, K, L, and M, *M. musculus* and *rattus*—in other words, *M. musculus* was found alone at one place of infection, *M. decumanus* alone at a second, *M. musculus* and *decumanus* at a third, *M. musculus, decumanus,* and *rattus* together at a fourth and fifth, and *M. musculus* with *rattus* at the remaining four. It should be borne in mind that these figures are not conclusive; they represent merely what happened to be discovered, and in reality show only that all three species suffer from plague, and have been found in association with cases in man. That *M. decumanus* alone may be an adequate cause of plague in man, however, was shown in the case of the s.s. "Antillean" (Report, 1902, pars. 50–65), and has recently further appeared from an outbreak in a distant part of the State, which will be made the subject of a separate report. In a farming district on a river about 300 miles north of Sydney, 12 cases, of which 7 were fatal, occurred in 10 houses. Considerable numbers of infected rats were collected, all of which were *M. decumanus*. Large numbers of uninfected rats were also examined, among which only a half-dozen or so of *M. rattus* were found.

15. The kinds of fleas found on the different species of rats caught at Sydney were determined by the Microbiologist (Dr. Frank Tidswell, M.B., D.P.H.), who has furnished the following statement (see also Reports, 1900, pp. 40, 56, and 57; and 1902, pars. 272 to 292):—

> As opportunity offered during the year, individual species of rodents were searched for fleas. Such opportunities were not particularly frequent, as most often different species were put together in the same parcel, so that fleas from one might easily have become transferred to another. Collections were only attempted when the animals submitted were all of one species. The opportunities were still further narrowed down by the fact that often no fleas were obtained under these circumstances. However, the results of this part of the work were as follow:—

TABLE I.—1904.

Species of Fleas.	*M. Decumanus.*	*M. Rattus.*	*M. Musculus.*	Total.
Ceratophyllus (pulex) fasciatus	1	3	6	10
Ctenopsylla (typhlopsylla) musculi	9	5	17	31
Pulex pallidus (cheopis, Rothsch)	76	5	12	93

F. T.

16. The 243 infected rodents were taken on 41 different premises between 1st March and 3rd December, but the last was taken on premises which had become infected much earlier. Freshly infected premises continued to be discovered only down to the 10th October. Further, although the first rodent in which plague was identified was collected by the intelligence staff on 1st March at Grafton Wharf (see Diagram, No. 1), unusual mortality among rats at 157, Sussex-street, on and after 29th February, was reported (see Diagram, No. 2). There plague was identified in two mice collected on 11th March, or the day after Case A (see below) had been notified in connection with those premises; it is probable, therefore, that the epizoötic began in that immediate neighbourhood, if not in that house. Although this would accord with previous experience, which has been that epizoötic plague has always first shown itself at some point of the line of wharves situated on the eastern shore of Darling Harbour, and in 1903 was first observed at the same part of this line (namely, at 153, Sussex-street*), yet I do not consider that the infection was thereby shown to have persisted from year to year. In the first place, while the line referred to included all the wharves at which the produce trade with other States was carried on, hay and chaff with us have been by far the most important kinds of merchandise in relation to risk of importation of plague; thus they were especially liable to reinfection. Secondly, although very many distinct areas have yielded plague-rats in number in the past during some one determinate period, no evidence of persistence of infection on any of them has ever been got. There has been, indeed, a single apparent

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* The odd numbers are all on the water side of this street.

exception; but this was Gray's stables, Waterloo (see Report, 1903, par. 25), and a similar explanation applied to it. About 100 horses were stabled there; the necessarily large and frequent supplies of fodder required for them were purchased in Sussex-street, and the infection did not reappear at the stables until long after the epizoötic of that year had declared itself in Sussex-street. All evidence has gone directly against such persistence, and against the view that plague is "a disease of locality" in that sense (*see* also pars. 40–1 below). The infection is "localised" in the rat. But I have not been able to see in the facts observed at Sydney evidence that it can persist in the rat in a chronic form which might serve as the starting point of a fresh and virulent outbreak, nor, in Dr. Tidswell's opinion, has a prolonged and carefully observed laboratory experience furnished any.

17. Of the 41 premises which yielded plague-rodents, 2 only were in private occupation. One of these stood next to a builder's yard, distant from the centre (see Diagram No. 14), where there was a small stable, which was also (probably first) infected, and from which rats could easily pass to it; no doubt the same horde infested both properties. Infection was carried to stables at the other private house *per saltum* from the Darling Harbour centre (see Cases L and M below). Fifteen of the remainder were classed as produce stores, 13 having been of that description, while 1 was a grist-mill and 1 a seedsman's; 12 of these stood on the water-side of Sussex-street. Other 14 were classed as wharves, and stores connected with wharves, 1 of them actually having been a small steamer lying alongside a wharf, and most probably infected from it. Then 2 others were timber-yards having water-frontage, 1 a builder's yard (mentioned above), 1 a distant paper-mill, 1 a general carrier's, 1 a wool-store, 1 a slop shop, 1 a show-room in an arcade, 1 the extensive basement beneath the same arcade, and 1 a public house. The infected cat came from another public house (making 42 places altogether) which yielded no rats. So that plague-rats were found only at places commonly infested with rats, with a few exceptions; and in some of those exceptions merchandise was known to have been imported to them from infected premises.

18. The position of the above-mentioned places is shown on the accompanying Diagram by spots which have been numbered consecutively in the order of date on which a plague-infected rodent was first observed at each of them; and in a table printed on the Diagram the addresses of the places are given. These have been consecutively numbered to agree with the numbers attached to the spots, and against each is mentioned, not only the first date on which a plague-infected animal was found at it, but also the last date. These two dates do not in all cases represent a continuous infection, and probably have resulted sometimes from reinvasion. By comparison of the numbers and dates thus given, with assistance of the Diagram itself, it is possible to follow the apparent course of the epizoötic; but close acquaintance with local conditions, which cannot profitably be made the subject of a description, is necessary to avoid error. Further reference to this part of the subject, therefore, is not made.

19. The 12 cases of plague in man, which were met with in the course of the epizoötic, were notified from 11 dwellings. Nine of the patients were adjudged to have been infected at their places of employment, the other 3 at their dwellings; but 1 of the latter was also employed away from home. Ten places of employment are therefore shown on the Diagram by the capital letters "A," "B," &c.; and 11 dwellings by the corresponding lower-case letters enclosed within a circle. Some houses in both of these classes stood on areas which did not fall within the limits of the Diagram, but a marginal note sufficiently indicates their situation. The number of adjudged places of infection was but 9, 3 cases having been associated in place with three of the others.

20. The circumstances under which the 12 patients received the infection were as follows. It will be observed that the clinical diagnosis was corroborated by the Microbiologist in every case by microscopical and cultural examinations, and that in some of them the test by inoculation was also employed:—

Case A.

Summary.—O.G., m., aet. 15, unmarried, errand-boy. No former attack; not inoculated; had had no communication with any previous case, nor with any sick person during 10 days before attack at least. Residence, 7, Isabella-street, Balmain, a suburb about 2 miles (in a straight line and across water) north-westerly from his place of employment, which was at 157, Sussex-street, a produce store. Notified by Dr. Shirlow, 10th March, 1 p.m.; visited by the Assistant Medical Officer of the Government (Dr. R. J. Millard, M.B., D.P.H.), at Balmain, 2 p.m.; admitted to hospital 10th March, discharged 21st April; duration of illness, 14 days. Right femoral bubo; morphological, cultural, and inoculation tests positive.

Movements prior to Attack.—For 10 days prior to attack had moved only between his residence and his employment by ferry; his duty required him to visit the North Coast wharf (at the back of his place of employment) every day, and a Newcastle wharf near by once a week. He took his lunch with him, and ate it at the store.

History of Illness.—Rose in usual health 9th March; went to work; at 9 a.m. was suddenly seized with shivering, nausea, general pains, and a sharp pain in the right groin; lay down, eat no lunch, but did not go home till 6 p.m. Became delirious during the night. At 2 p.m., 10th March, the bubo was of the size of a small marble; there was a little periadenitic effusion. Said he had lately caught several fleas on his legs and body, and had killed them; the premises (employment) were infested with fleas; there were traces of numerous flea-bites on legs and abdomen; no other lesions.

Residence.—Weatherboard cottage, semi-detached, one storey, three rooms; repair and cleanliness, fair; no trade-use; no stable near. Connected with sewers. General sanitary state, fair. Bedroom disinfected 11th March.

Employment.—Stone, good repair; used as a produce store. One floor, concrete covered with hardwood planks in close contact; clean; lighting, fair; ventilation poor. Searched and cleansed 11th March; no goods destroyed.

Rats.—At residence: occupants and neighbours said none had been seen in that neighbourhood for about four years; there were no signs of infestation. At employment: 29th February patient noticed a bad smell, and after search discovered 2 dead rats in the store; on 1st, 2nd, and 3rd March, he found 1, 2, and 2 dead rats; he lifted all of them with a board, and put them in the street gutter. Cleansing staff discovered 7 more carcases on 11th March, 5 (rats) advanced in decomposition; in the other 2 (mice) plague was identified. As regards the immediate neighbourhood, one *Mus rattus*, sick, had been killed 9th March on the roof of 161, Sussex-street (next door but one to No. 157), by a man sent by the Harbour Trust to do repairs; it was delivered at the laboratory where plague was identified in it, morphological, cultural, and inoculation tests having yielded positive results.

Contacts and further Cases.—At residence, 6; at employment, not noted. No further cases.

CASE B.

Summary.—R.W.W., m., aet., 23, married, labourer. No former attack; inoculated at Sydney, 1900; had had no communication with any previous case. Residence, Underwood-street, Paddington, about 2 miles south-easterly from his place of employment, which was at the Grafton Bond, Darling Harbour (northerly end of Sussex-street). Notified by Dr. O'Gorman Hughes, 13th April, midday; visited by the Assistant Medical Officer of the Government, at Underwood-street, 3·15 p.m.; admitted to hospital 13th April, discharged 17th May. Duration of illness, 38 days. Right femoral bubo; morphological, cultural, and inoculation tests, positive.

Movements prior to Attack.—Regularly employed for many weeks at Grafton Bond G, to which a wharf was attached, and which contained cased goods, spirits, drapery, &c.; was entirely employed within the bond; went to work by tram, left at 5·45 and usually went straight home; on 10th April (Sunday) went to Coogee; had not seen any rats at the bond for 14 days past. Took his lunch to the bond, and ate it there. Employers said that although he worked well enough during the day, he drank, and his home was miserably poor.

History of Illness.—10th April, afternoon, while amusing himself at Coogee felt pain in right groin; no headache, &c. 11th, went to work; about midday headache and malaise set in, with increased pain in groin where he then found a lump about the size of a marble; slept little that night. 12th April, went to work again at the usual time; headache, vomiting on rising, and fever; was unable to continue after midday, and returned home. 13th April, at 2·30 p.m., two or three right femoral glands were found enlarged, not very tender, the largest the size of a marble; T. 99·2, P. 105, pale, not apparently very ill. On the right leg were one or two scratches made by finger-nails, no other lesions; no flea-bites visible (the skin was very dirty).

Residence.—Terrace house, 3-storeys, 6 rooms, brick; connected with sewers; cleanliness and general sanitary state, fair, except a basement which dirty and damp. Patient, wife, and infant occupied one room, almost destitute of furniture; bedding burnt because filthy. Room disinfected 14th April. No trade use; no near stable, &c.

Employment.—A new building, sound in all respects; basement floor concrete, other floors not ceiled. Searched as far as possible 13th April.

Rats.—At residence, no signs of infestation; tenants said none seen. At employment, a little rat-dung was found in a few places, no carcases. 1st March, plague was identified in the carcase of a mouse taken at Grafton Bond in a building in which the patient worked when he was not wanted at the building to which he was more especially attached (Bond G); and on 27th April, 14th and 31st May other plague rodents which had been taken at different parts of the collection of buildings which constituted Grafton Bond, were detected among a total of 796 rodents submitted on 81 days between 24th February and 31st May. On 14th, 18th, and 20th April, 3 plague-rats were taken at Adelaide Wharf No. 1 (otherwise called Grafton Wharf), which lay within 50 yards of the bond.

Contacts and further Cases.—At residence and at employment, not noted. No further cases occurred.

CASE C.

Summary.—H.M., m., aet. 36, married, a seedsman. No former attack; not inoculated; no communication with any previous case. Residence, Morgan-street, Marrickville, about 3½ miles south-west from his place of employment, which was at the corner of Pitt and Campbell streets, where he had his shop. Notified by Dr. G. H. Abbott, 22nd April, 10 p.m.; visited by the Assistant Medical Officer of the Government at Marrickville, 23rd April, 10 a.m.; admitted to hospital 23rd April, 3 p.m.; discharged 1st June; duration of illness, 43 days. Right femoral bubo (later a right inguinal gland became enlarged); morphological, cultural, and inoculation tests positive.

Movements prior to attack.—H.M. occupied a retail shop at the corner of Campbell and Pitt streets. In Belmore Market (vegetables, seeds, produce, &c.) across Campbell-street, he had a small bulk store, an apartment built of and floored with wood within the stone-paved market, with a frontage to the eastern end of the latter. Spent most of his time at his retail shop, but canvassed for business in the markets on

Tuesdays, Thursdays, and Saturdays. He visited the bulk-store 11th April, and from then till the 16th was occupied at his retail shop; 17th April (Sunday) went early to bathe at Lady Robinson's Beach, thereafter at home; 19th April visited the bulk-store, where he remained about ten minutes, and saw some bags of canary-seed turned over during the morning; 20th was occupied entirely at the retail shop.

History of Illness.—20th April went to work as usual, and continued in usual health throughout the day; went to bed still well; was roused about 11·30 p.m. by headache, pain in the loins, shivering, fever; he vomited before daybreak. 21st, eat no breakfast; was visited by Dr. Abbott, who examined the superficial lymphatic glands, and found they presented no enlargement or tenderness. 22nd, afternoon, pain in right groin, where he felt a small lump. 23rd, 10 a.m., exhibited a visible swelling in right Scarpa's triangle, which was caused by an enlarged femoral gland and a good deal of periadenitic effusion (1st June a second femoral and an inguinal gland had become slightly enlarged). Distinct remains of a flea-bite were seen 5 inches above the right external malleolus, and there were three others on the lower part of the abdomen (patient said he was rarely or never bitten by fleas); no other lesions of drainage area.

Residence.—Detached villa, brick, one storey, six rooms; three aviaries and a fowl-house; no stable in near neighbourhood; no trade use. Connected with sewers; clean, and in good sanitary state; one bedroom disinfected 23rd April.

Employment.—The building was of one storey, and contained one room only; not in communication with any other building.

Rats.—At residence, no traces. In the course of routine inspections the retail shop had been found rat-infested, and the owner had consequently been served with notice to put in a concrete floor on 30th March; at the date of attack this work was still in progress, so that few signs of infestation were then visible. Rat-catchers of the City staff had been at work at the market and in its neighbourhood for many days; on 19th April one of the carcases delivered by them at the laboratories was found to be plague-infected. On removal of the stock from the bulk store in the markets, which consisted of about 80 bags of canary-seed, to another place (it was not further interfered with), the wooden floor was found to be full of rat holes, and on taking it up burrows were traced under the flagstones of the market pavement and under the adjoining street pavement; the earth was excavated to a depth of about 3 feet, and it was found that the burrows extended many yards. This work was carried on between the 19th and the 25th; it resulted in collection of 83 rats, in 24 of which plague was identified (65 were gathered on the 21st and 22nd, of which 17 were infected). Portion of the stock of canary-seed had been recently landed at Adelaide Wharf, where plague-rats had been found on and after 14th April.

Contacts and further Cases.—At residence, 4; at employment not noted; no further cases occurred.

CASE D.

Summary.—W.O'N., m., æt. 17, unmarried, labourer. No former attack; not inoculated; no communication with any previous case. Residence, Factory-street, Parramatta, about 14 miles from his place of employment, which was at Wearne's grist-mills, Dixon-street, within the city of Sydney. Notified by Dr. R. Bowman at midday, 25th April; visited by the Assistant Medical Officer of the Government at Parramatta District Hospital, and reported for removal at 3·10 p.m.; admitted to Coast Hospital, April 26th, 6 p.m., patient's state and length of journey by road having rendered delay necessary; discharged 2nd June; duration of illness, 40 days. Right femoral bubo; morphological and cultural tests positive.

Movements prior to Attack.—Was out of work, went frequently to Sydney by train, and visited many different suburbs. 16th April engaged at Wearne's mill, to begin 18th; remained at home 17th (Sunday), and thereafter moved only between his house and the mill.

History of Illness.—22nd April, 1 p.m., felt pain across loins, and at 3 p.m. pain in right groin; he was giddy and weak, but finished his day; shivered during the evening, went to bed at 9 p.m., and remembered nothing thereafter until he came to himself in Parramatta Hospital, where he was admitted 23rd, 7 p.m. On examination, 25th, exhibited a right femoral bubo about the size of a pigeon's egg, with some periadenitic effusion; no lesions of drainage area, except flea-bites.

Residence.—Detached brick and weatherboard cottage, one storey, four rooms; walls damp; pail-closet, clean; no trade carried on; no stable in close neighbourhood. One bedroom disinfected 26th April.

Employment.—An old brick building, five storeys, very much out of repair; wooden flooring in basement; a good deal of maize, wheat, and oats awaited grinding.

Rats.—At residence, no signs. At employment, patient said he had seen none; on inspection there were signs of past and present infestation, and between 27th April and 5th May 71 rats and 29 mice were collected; plague was identified in 2 rats and 2 mice.

Contacts and further Cases.—There were no further cases.

CASE E.

Summary.—W.J.J.H., m., æt. 33, married, carter. No former attack; not inoculated; no communication with any previous case. Residence, 96, Reservoir-street, City, about a quarter of a mile from his employment, which was at Hop Lee and Company, fruit salesmen, 26, Campbell-street, City. Notified by Dr. Corlette, 26th April; visited by the Senior Medical Officer of Health (Dr. W. G. Armstrong, M.B., D.P.H.) at 2 p.m., and reported for removal same time; admitted to Coast Hospital 26th April, 5·30 p.m.; died, 30th April; duration, 84 hours. Right femoral bubo; morphological and cultural tests positive (later, inguinal glands enlarged as well).

Movements prior to Attack.—In his present employment, five years; was occupied in carting fruit, &c., from Sussex-street wharves to Campbell-street every day; delivered a load at Adelaide Wharf, No. 1, otherwise called Grafton Wharf, 22nd April; 23rd April (Saturday), afternoon, paraded with Field Artillery; last at work, 25th April, 6 p.m.; stabled his horse at livery stable, 28, Campbell-street.

History of Illness.—Worked as usual, 25th April; afterwards went to Victoria Barracks; retired to bed in usual health; attack sudden about midnight; felt first a sharp pain in right groin, and found a small lump; then high fever and general weakness; no other pain. 26th April, 2 p.m., exhibited a small right femoral bubo about the size of an almond, not painful and only slightly tender. On limbs and chest was an extensive inflammation of the hair follicles caused by dirt; at many points there were small pustules. No other lesion of the drainage area visible.

Residence.—Two-storey cottage, in a terrace; brick, clean, good repair; connected with sewers; no trade use; no stable near. One bedroom disinfected 27th April.

Employment.—Brick, concrete floor to basement, very clean and well kept.

Rats.—At residence, no traces; at employment, no traces. At Grafton Wharf, where patient had delivered a load 22nd April, and was occupied nearly all day, plague-rats were taken 14th, 18th, and 20th April.

Contacts and further Cases.—At residence, 4; at employment, not noted. No further cases occurred.

CASE F.

Summary.—C.E.C., m., æt. 33, single, labourer. No former attack; not inoculated; no communication with any previous case. Residence, 68, Druitt-street, City; employment, Town Hall close by. Notified by Dr. Morgan Martin, 12th May, 9·30 a.m.; visited by the Assistant Medical Officer of the Government, 10 a.m.; reported for removal at 11 a.m.; admitted to Coast Hospital, 2·30 p.m.; discharged, 3rd June; duration of illness, 27 days. Left femoral bubo; morphological and cultural tests positive.

Movements prior to Attack.—Patient had been a member of the cleansing gang employed by the Local Authority for the City of Sydney for a long time. Was occupied in cleansing Wearne's grist-mill (see Case D), 28th April to 5th May (on the included Sunday he stayed at home); 6th and 7th May he was employed at other premises where no plague-rats had been or were afterwards found.

History of Illness.—8th May (Sunday) felt slight pain in left groin on stooping to put on his boots, and found a small lump; was well, eat breakfast, went to bathe at Coogee, returned; at 11 a.m., found himself too tremulous to shave; soon after became giddy, frontal headache began, eyes became suffused and ran, and he found the lump in the groin more tender and larger. Afterwards he shivered from time to time, and at 3 p.m. noticed the bubo had become still larger. Thereafter he experienced the usual symptoms in rather slight degree, including sleeplessness; but on the night 11th to 12th, he slept well. At examination 12th May, he exhibited a left femoral bubo, which consisted of two glands enlarged and enveloped in a mass of effusion, the whole about the size of a pigeon's egg.

Residence.—A three-storey brick house of eight rooms in a terrace; cleanliness and general sanitary state fair to good; connected with sewers. Premises used as a lodging-house; no stables near by. One bedroom disinfected 12th May.

Employment.—See Wearne's mill, Case D.

Rats.—Residence, one rat-hole in a front room was evidence of past infestation; but there were no present signs. Employment, see Case D, Wearne's mill.

Contacts and further Cases.—At residence, 18; at employment (engaged together with him in cleansing the mill), 10. No further cases occurred.

CASE G.

Summary.—G.C., m., æt. 49, married, labourer. No former attack; inoculated Sydney, 1900; no communication with any previous case. Residence, 31, Murray-street, Pyrmont, within the city, about half-a-mile across Darling Harbour from his place of employment, which was at Federal Bond and Stores, on the easterly shore of Darling Harbour. Notified by a member of the Departmental rat staff, 27th May, 9·30 a.m.; visited by Assistant Medical Officer of the Government, 10·30; reported for removal, 11·45; admitted to Coast Hospital, 5·15 p.m.; discharged, 9th August; duration of illness, 46 days. Left femoral bubo; morphological and cultural tests positive.

Movements before Attack.—Was regularly employed as a store hand at Federal Bond and Stores for long before illness, and was last at work 26th May. Walked to and from work, and ate his lunch on the premises.

History of Illness.—25th May, went to bed in usual health; was roused by severe frontal headache and shivering about 11·30 p.m.; was giddy and weak on rising next morning, but went to work; at 10 a.m., 26th May, noticed a slight cutting pain in the left groin, and at 11 went home; during the evening noticed a severer pain in the groin, and found a lump there; was visited by his lodge doctor at 6 p.m. On examination, 27th May, the bubo consisted of two or three enlarged femoral glands, of which the biggest was the size of a marble. No lesions of drainage area were visible (skin very dirty).

Residence.—A two-storey brick cottage of four rooms in a terrace; connected with sewers; no trade use; cleanliness and ventilation bad; walls, ceilings, and bedding dirty and infested with bugs. No stables in close neighbourhood. One bedroom disinfected 28th May.

Employment.—A brick building of two storeys, and four large sheds of iron and wood, in which a variety of articles were stored, among them a large quantity of oats, wheat, barley, and chaff. He was occupied in moving, stacking, &c., the articles in store.

Rats.—At residence, no signs. From Federal Bond, Stores (diagram No. 15), and adjoining wharf 21 rats were submitted between 25th and 28th May, of which 4 were infected with plague. 24th May, patient said he found a dead rat in one of the stores, which he wrapped in paper and gave to the rat-catcher (rat-catcher confirmed this); this rat yielded smears which aroused suspicion of plague, but the cultures which were made became overgrown; 25th May, he found another, which he also wrapped in paper, and gave to the rat-catcher; the rat-catcher himself took another rat at the bond, and submitted both; plague was identified in one of them, but there was nothing to show which of the two was that picked up by the patient. (Cf. Case L below.)

Contacts and further Cases.—At residence, 4; at employment, not noted. No further cases occurred.

CASE H.

Summary.—W.W., m., æt. 20, unmarried, labourer. No former attack; not previously inoculated; had had no communication with any previous case. Residence, Raglan-street, Waterloo, about 6 miles north of his place of employment, which was at the Federal Paper Mills, Botany. Admitted to the general wards at the Coast Hospital, 31st May; died, 6th June; duration of illness, 6 days. Slight swelling of a right femoral gland (first appeared sixth day); morphological, cultural, and inoculation tests positive.

Movements before Attack.—Had been employed at the paper-mill for a considerable time, and the books showed that he had recently been absent only for an hour on 17th, and for half a day on 18th May, when (his relatives said) he had a bad cold. He went to and from work by tram, and had spent his own time either at home or in his neighbourhood, but on Saturday nights he usually went into the city for amusement.

History of Illness.—His relatives said he was an epileptic, but was well before, and on the day of, attack. He was brought to the hospital 31st May, on a lorry, by his fellow workmen, who said he had worked as usual during the morning, and had eaten a good lunch at 12; he resumed work at 1 p.m.; at 2·30 he shivered, became giddy, and complained of general pains about the body; very soon afterwards he staggered out of the shed, where he was occupied in sorting rags, and fell to the ground; he was unconscious, or, as his friends said, "his face was flushed, and he would not answer questions"; he was further said to have had a convulsion on the way to the hospital, where he arrived about 3 p.m. He was admitted to a general ward under care of a Medical Officer (Dr. W. W. Stevens, M.B., B.Ch.) of considerable clinical experience with plague. This disease was borne in mind in making the diagnosis, and the superficial lymphatic ganglia were examined daily. His symptoms consisted almost entirely in high fever, delirium with great restlessness, a slight cough from the beginning, epistaxis, some diarrhœa, and meteorism; commencement of the sixth day (5th June, evening) tenderness was found in the right groin, where, twelve hours later, one of the femoral glands had become a little bigger than a pea; at the same time the physical signs of pneumonia became apparent over the right base, and were fully developed the next morning. He died at 11·30 a.m., 6th June. No examination was made *post-mortem.*

Residence.—A weatherboard cottage of one storey, four rooms; a poor place, tolerably clean, but in bad sanitary condition; no trade use; no stables very near. Not disinfected.

Employment.—A paper-mill, about 6 miles south of residence, standing on scrub land, near swamps. The premises were very extensive, not old, and very well constructed; concrete floors throughout—to sorting-sheds as well as to brick buildings. There was a large stock of material awaiting manufacture, which amounted to about 7,500 bales; it consisted of some rags, but chiefly of waste paper, rope, jute bagging, &c., &c. There were about 2,000 cubic yards of similar matter which had been dumped in the open, and had there rotted. The place was cleansed by a staff of men employed by the company, but under direction of Departmental sanitary inspectors; the stock was moved, enclosed under tarpaulins, fumigated with sulphur for expulsion of rats (if any), and restacked. The rotting material was spread out in a layer 18 inches thick, and covered with engine-ashes, after having been sprayed with miscible carbolic.

Rats.—At residence, no signs of infestation. At employment, between 10th and 23rd June, rat-catchers submitted 34 rats, 125 mice, and 5 native cats (*Dasyurus Viverinus*, Shaw); the cleansing staff found only 1 rat with 4 young, 6 mice, and 2 native cats; no holes, burrows, &c. Plague was identified in 1 rat taken 10th June, and 1 mouse taken 16th June; the whole number were examined in the laboratory in the usual way, but all had been trapped, and, therefore, were either all in good health, or if at all infected but slightly so. The premises themselves offered no signs of infestation, and it was conjectured that the rodents taken were introduced with the bales of material which were delivered daily. The supplies referred to were collected at two places adjoining each other in Harbour-street, Darling Harbour. One belonged to the company, the other to a rag-dealer; they were situated next to Wearne's mill (see Case D), and both had doors which opened on a yard on which Wearne's mill also opened. At the latter place plague-rats were taken between 27th April and 3rd May, but not later.

Contacts and further Cases.—At residence, 4; at employment, 63 men and 44 women were employed—total, 107; 37 were occupied in the sorting-shed, where W.W. worked. No further cases occurred.

CASE I.

Summary.—R.S., f., æt. 15, unmarried, milliner's apprentice. No former attack; inoculated Sydney, 1900; no communication with any previous case. Residence, Town's Wharf, Miller's Point, about a mile from her place of employment, which was at 502, George-street, City. Notified by Dr. E. H. Binney, 21st June, midday; visited by the Assistant Medical Officer of the Government at 12·30; reported for removal 2 p.m.; admitted to the Coast Hospital 6·30 p.m.; died 22nd June, 6·30 p.m.; duration of illness, 76 hours. Left sub-pectoral and left cervical buboes; morphological test applied to liquid from a swollen gland, and to blood withdrawn from the general circulation, 21st June, midday, both positive.

Movements before Attack.—Between residence and employment only.

History of Illness.—Was in good health. 19th June went to work as usual; at 3 p.m. shivering and frontal headache; 20th June, first felt pain about the left axilla, which gradually increased; during the evening her pulse and temperature were normal (Dr. Binney); during the ensuing night first felt pain in the left side of the neck. 21st June, midday, T. 102·4, P. 128; exhibited a small, very tender, bubo under the border of the left pectoralis major; just above the clavicle a slightly enlarged and tender posterior cervical gland was detected. Death by cardiac failure.

Residence.—Town's Wharf, where her father was watchman. A brick two-storey cottage of six rooms, which was attached to, and formed part of, a bonded store, from which it was separated by a wood-and-iron partition; lighting and ventilation bad; the patient's bedroom had no outside window. Three rooms disinfected 22nd June.

Employment.—A brick house of three floors, in a satisfactory state; patient worked in a room on the second floor, which was in good sanitary condition.

Rats.—Residence. Dead rats were found beneath the kitchen floor and at parts of the adjoining bonded store; the carcases were putrid. During the 115 days—1st February to 25th May—89 successful visits had been paid to this wharf and the stores in the enclosure attached to it; they yielded 136 rats and 73 mice, all of which had been examined in the laboratories, and had been found healthy. On 26th and 27th May, 7 rats and 3 mice were submitted, of which 3 rats and 1 mouse were infected. Between 30th May and 13th June, 11 successful visits yielded 17 rats and 18 mice, all of which were healthy. On 14th June, 2 rats and 2 mice were brought in, of which 1 mouse was infected. During 136 subsequent days 61 successful visits were paid to these premises; they yielded 44 rats and 61 mice, all of which were examined in the laboratories, and were found to be healthy. At employment, no trace of infestation.

Contacts and further Cases.—No further cases occurred.

CASE K.

Summary.—L.B., m., æt. 40, married, shipping clerk. Residence, 187, Edgecliffe-road, about 3 miles south-westerly from his place of employment, which was at 170, Clarence-street, City. No former attack; not inoculated; no communication with any previous case. Notified by Dr. O'Gorman Hughes

3rd August, 1·30 p.m.; visited by the Assistant Medical Officer of the Government at 3·40; reported for removal at 5·10; admitted to the Coast Hospital 9 p.m.; died 4th August, 9·30 a.m.; duration of illness, 96 hours. Bubo, left sub-pectoral; morphological and cultural tests positive.

Movements before Attack.—Had been at his business regularly for a considerable time; he was chiefly occupied at his office in Clarence-street, but had to visit daily the head offices of various shipping companies which were not near wharves; and he had visited only one wharf during the preceding three weeks, namely, the office attached to Howard Smith and Company's wharf, where he called 30th July; otherwise he had moved only between home and place of employment.

History of Illness.—30th July (Saturday) in good health, went to work as usual; in the afternoon had headache, but eat a good tea, went to an election meeting in the evening, and slept well at night. 31st, shivered at 8 a.m., felt generally unwell during the morning, headache, giddiness, and vomiting; uneasiness in left axilla about 9 p.m. 1st August, still felt feverish, vomited several times, restless, no appetite, the axillary pain was much increased and a lump was felt. 2nd August, same symptoms; did not feel very ill. 3rd August, first sought medical advice. About midday was found in bed, feeling weak, not apparently very ill; had had some diarrhœa, complained of axillary pain; the bubo consisted in a large doughy mass, in which a gland could be felt; T. 102·8, P. 99, R. normal. Lesions of drainage area, none. He subsequently said he had cut his left thumb slightly on radial side of nail with a penknife 24th July; this had bled on 25th and 26th while he was at his office, and he had dried up the blood with blotting-paper. Died 4th August, 9·30 a.m., cardiac failure, mind clear.

Residence.—Brick terrace house of five rooms, with basement; connected with sewers, very good sanitary condition, and very clean; no trade use; no stable near. Bedroom occupied by patient disinfected 5th August.

Employment.—A warehouse used by a firm of carrying agents, brick, four floors, excellent repair, general sanitary condition good, cleanliness fair; patient's office on ground-floor; no stables or outhouses; basement concreted; all rooms ceiled wood. A considerable store of general merchandise, including a few bales of hops and about 2 tons of bird-seed. Searched and disinfected 5th August.

Rats.—At residence, no traces. At employment, search revealed abundant signs of present infestation, in the shape of fresh dung, and the carcases of three or four recently dead rats; rat-dung was found in a drawer of the desk which deceased used habitually; plague was identified in the carcases of 2 rats and 1 mouse collected in the store 4th to 8th August.

Contacts and further Cases.—At residence, 1; at employment, 11 men, 1 woman. No further cases occurred.

CASE L.

Summary.—P.D., m., æt. 26, single, a coachman in private employment. No previous attack; not inoculated; no communication with any former case. Residence and employment, Curzon Hall, Marsfield, a suburb of North Sydney; but on 9th September, after falling ill, went to his father's house, 228, Trafalgar-street, Annandale, a suburb of Sydney. Notified by the Coroner 11th September; duration of illness, 51 hours. Notes of the *post-mortem* examination were furnished by Dr. Stratford Sheldon, by whom they were made about fourteen hours after death:—"*Rigor mortis* and *post-mortem* lividity well marked; no swellings or marks of identification. The inguinal glands were dissected out; they were rather high-coloured on both sides, but not enlarged; cervical and axillary glands were not enlarged. The blood was dark and tarry. There were signs of ecchymosis in the loose tissue around the right eye, and sub-conjunctival ecchymosis of the left eye. Brain, intense venous congestion. Heart: about two drachms of clear fluid in the pericardium; left side engorged with clots; right side empty; petechial subserous hæmorrhages. Pleuræ contained about an ounce of clear fluid in each; the lungs were quite normal in appearance, and there was no congestion. There were very marked subperitoneal ecchymoses on the posterior wall of the abdomen, and the areolar tissue round the kidneys was intensely congested with dark venous blood; there were subserous hæmorrhages on the small intestine at various points; the kidneys were swollen, soft, very full of dark blood, and showed subserous petechial hæmorrhages. The liver was about normal, no marked congestion. Spleen large, soft, very congested. The bladder was empty. Both iliac veins were congested; the left appeared to be inflamed, and was full of breaking-down clot." To a portion of the spleen which had been preserved in carbolic solution the Microbiologist applied morphological, cultural, and inoculation tests with positive results.

Movements before Attack.—Had been in his present employment two years. Went to Annandale 3rd September, returned 4th, evening.

History of Illness.—It was ascertained, after examination of several members of the household, that he was in his usual health during the forepart of 7th September; but that while driving a carriage to meet the train late in the afternoon he complained of shivering to a fellow servant who accompanied him. Having returned, he put his horses up, changed his clothes, and went to a party at a neighbour's, but was too unwell to stay more than half an hour. 8th September, remained in bed all day; he was visited and attended from time to time by M.L. (Case M, see below), the housekeeper, and by Mrs. G., an occasional domestic assistant; he had headache, fever, and vomiting. On 9th September, he decided to go to his parents, at Annandale; he went to Sydney by train, and arrived at Annandale about midday. At 5 p.m. he was visited by Dr. H. B. Ludlow, who found him suffering from diarrhœa and vomiting, tongue and lips dry, T. 103; he had a swelling along the inner side of the left thigh, which was not markedly tender, and tenderness in the right hypogastric region; his general state was described as having been "typhoidal." About 8·30, Dr. Ludlow returned, and found the patient had just died; he noted that the body was already livid, and growing darker. He declined to certify to the cause of death, and informed the police.

Residence (of parents at Annandale).—A detached weatherboard cottage, one storey, five rooms, one fowl-house; general sanitary state good; connected with sewers; no trade use; no near stable. Bedroom where patient had lain disinfected 12th September.

Employment (Curzon Hall, Marsfield).—A private residence standing on a considerable area of land; built of stone, two stories, twenty-six rooms, large basements; general sanitary state satisfactory. The patient inhabited the stables. These were of stone, two stories. On the ground-floor was stabling for six horses; at one end a kind of office, at the other a coach-house, harness-room, and a lumber store. On the upper floor was a large loft over the stalls, which contained about 220 bags of chaff, oat husks, &c.; over the coach-house, &c., were some empty rooms; and over the office was the patient's bedroom. There were other structures in the grounds which, after examination, turned out to have no special importance in the present connection; and about 400 yards from the house was a large building, partly of stone, which was sometimes used as a church. It contained one room, used as a bedroom by some out-door servants, as well as three basement rooms, of which one was used as a store for chaff, and contained about twenty bags. Between 12th and 17th September the premises were cleansed by a staff of six men, furnished by the proprietor, assisted by two members of a former cleansing staff, under direction of Departmental Sanitary Inspectors Getting and Lloyd. Occasion for cleansing operations was found to be confined to the stables and the distant building last-mentioned; they were disinfected and lime-washed. The bags of feed were examined, broken bags being opened out. Between 80 and 90 such bags were burnt, together with their contents; the sound bags were merely ransacked, and were not otherwise interfered with.

Rats.—Inquiries made of different persons showed that before he fell ill deceased had killed a sick rat which he saw crawling across the floor of his bedroom when he rose one morning, and had at the same time found two dead rats either in his bedroom or in the loft on which it opened. He had told this to his sister at Annandale, to a friend at Marsfield, and to one of the outdoor servants at Curzon Hall, all of whom were separately questioned. One of these witnesses thought he had said he found the rats on the 6th; one could only remember that he had said the finding happened about the 6th—that day having been the day before his attack, and the time referred to about 30 hours before attack. The third witness thought he was told it happened "two days before he fell ill," or on the 5th. It appeared that no other dead rats had been observed with exception of 2 reported by the stable boy; the date on which he saw them could not be fixed, and they may have been part of the three above-mentioned. The stable was found to be badly infested; rat droppings were thickly strewn over the floor of the loft and the chaff bags, which latter were also rat-eaten; much loose chaff, intermingled with rat-droppings, lay about the floor; three putrid carcases were found in a coil of rope about 3 yards from the bedroom door; the other rooms on that floor, and the rooms (except the stalls) on the ground floor were similarly bestrewn. But there were no burrows or holes in the woodwork, and nests were found only among the chaff and in the harness-room (the buildings were not only solidly constructed and in good order, but stood on a soil which was either shale or, in places, very hard clay). A similar state of things was found at the distant building above-mentioned, in some parts of it; and the chaff stored there was part of the same consignment as was stored at the stables. Many stacks of timber, as well as green-houses, bush-houses, &c., and other places existed in the extensive grounds, which seemed likely to afford harbourage for rats; they were carefully examined and found not to be infested. The house itself offered no signs of infestation; traps, decoy-baits, &c., were set, and 1 rat and 1 mouse, which were healthy, were caught; but it was thought they had wandered in. The statement of the experienced officers who supervised the operations throughout was that the presence of rats was connected with the forage, and as a matter of fact it was confined to the stables and to the distant building, in which two places alone the forage had been put. Between 12th and 16th September remains of 56 rats, collected on these premises, were referred to the laboratories. Eleven were skeletons only; 24 were decomposed, but had died rather recently; 14 had been trapped; 2 had been killed; 5 had been found dead. Plague was identified in 2 trapped rats from the stables, and in 1 rat killed at the distant building. Additional were 4 mice trapped at the stables, in one of which plague was identified. The horse feed found on the premises had been supplied by a dealer trading at 9, Wharf-street (Diagram No. 24), from the beginning of the year; he made the general statement in reply to his customer's inquiry by letter that the latter's supplies had been usually forwarded direct from the railway yards by train (that is, without having been at Wharf-street), but that 167 bags of chaff, delivered 11th May, had lain for 3 or 4 months previously at Federal Stores (Diagram No. 15), while the corn, or some of it, had been forwarded direct from the North Coast Company's wharf (north of No. 10 Diagram). Deliveries by this dealer at Curzon Hall (to limit inquiry to the important period) had been as follows:—11th May, 167 bags of chaff; 12th May, 8 bags maize; 27th May, 70 bags chaff; 28th June, 14 bags maize; 27th July, 10 bags maize, 7 bags bran; 1st August, 80 bags chaff. Then as regards rats, it is only necessary to say here that plague-rats were first detected at Federal Stores on 25th May, and were again found there on 14th June; they were also found in great number at the dealer's own store, 9, Wharf-street, and first on 24th June. But under the circumstances, while any produce store in the neighbourhood may have had importance in relation to infection of Curzon Hall—and many yielded plague-rats at one or another time—at all events two produce stores next to No. 9, namely, Nos. 7 and 5, should be noticed, although they were not, as far as could be learned, in communication with No. 9 for rats, and at all events were ostensibly separate premises. Then, plague-rats were found on No. 5 on 16th June, and at No. 7 on 7th to 11th June, and again between 1st and 9th July. These are the available facts; nothing further could be discovered, but it can be added that feed was supplied only by these dealers. Comparison of the dates of attack, of delivery of supplies, and of discovery of plague-rats at the stores does not make it possible to fix on any particular delivery as having been that which conveyed the infection. One point, however, seems ascertained: it is that the infection must have reached Curzon Hall at least 36 days before it was revealed by its effects on the stable rats, because the latest delivery was made 1st August. Our records in general show, however, that plague may persist among a horde for long without making much progress or infecting a large proportion of it, and it may well be that the infection was conveyed in a still earlier consignment.

Contacts and further Cases.—At Annandale, 4. At Curzon Hall 1 further case occurred. (See Case M.)

CASE M.

Summary.—M.L., f., æt. 31, single, housekeeper. Residence and employment, Curzon Hall, Marsfield. No former attack; not inoculated; had had communication with P.D., Case L, whom she attended while he lay ill in his room at the stables. Notified 12th September, 12·30 p.m., to the Assistant Medical Officer of the Government, who was then examining the premises in connection with Case L. Died 3·50 p.m.; duration of illness, 53 hours. Morphological and cultural tests, positive.

Movements before Attack.—Had been employed for a considerable time, and had not been away from the premises for fourteen days or more.

History of Illness.—10th September: rose in her usual health; at 11 a.m., headache, shivering, and "bilious feeling"; slept well during the ensuing night. 11th September: morning, felt generally worse; vomited frequently thenceforward; in the evening diarrhœa set in, and continued thenceforward. 12th

September: early in the day noticed a small and tender swelling in the right groin. Medical advice was not sought. On examination at 12·30 p.m., T. 103·2, P. 152, R. 34; tongue lightly coated, moist, lips dry; evident appearance of illness; very nervous, and frightened by the death of P.D.; a right femoral gland was slightly enlarged, not very tender, and there was also slight enlargement of right inguinal glands; morphological test applied to liquid abstracted from the former, and to blood taken from the right middle finger, positive; the former contained innumerable, the latter abundant, bacilli. About five small punctate marks, like flea-bites, over surface of bubo; no other lesions. A fellow servant with her at 3·50 p.m. said she had been talking rationally, when she suddenly gasped and died.

Residence and Rats.—See Case L. above. M.L. slept in the house. 8th September she visited P.D., who then lay ill in his bedroom over the stables, to see to his wants, and was reported to have sat with him during part of the night 8th to 9th. Mrs. G. (the casual assistant mentioned above under Case L) also sat with P.D. from time to time. Contacts, 8. No further cases occurred. The bedroom occupied by this patient was alone disinfected.

21. The buboes were femoral in 7 cases—A, B, C, D, E(d)*, F, and G; in cases C and E(d), some or all of the associated inguinal glands became tangibly swollen later. They were subpectoral in two cases, K(d) and I(d); the former remained solitary, the latter was followed by painful, hard swelling (a secondary bubo) of a cervical gland on the same side.

22. These 9 primary buboes made appearance as follows:—There was pain in the gland before other symptoms in cases B, E(d), and F, accompanied in F by slight swelling; there was pain at the onset, with other symptoms, in Case A; in Cases D, G, K(d), I(d), and C, pain (accompanied in C by observed swelling) was first felt in 2, 10, 13, 18, and 40 hours after attack, respectively.

23. It should be specially noted that in at least 3 cases out of the 12 the disease-process clearly first manifested itself in that gland in which a primary bubo subsequently developed. This was also observed in 13 cases of the outbreak of 1902 (Report, 1902, par. 24.)

24. In the other 3 cases, H(d), L(d), and M(d), defined buboes were not exhibited. In the case of H(d) there was no tangible swelling of any superficial gland (careful daily examination was made) until the 6th and last day of illness; in that of L(d) there was no tangible swelling of any gland during life, but all were found engorged *post mortem*; in that of M(d) there was slight tangible but not very tender swelling of the right femoral and inguinal glands only, which was detected about the 48th hour of illness, when the patient was first examined—*i.e.*, about 4 hours before death.

25. The following note on the bacteriological diagnosis of the cases, and on presence of the bacillus in the blood-stream during life, has been furnished by the Microbiologist.

The results of examinations of material taken from the buboes or enlarged glands, and of blood taken from the ear (including with the latter material from the spleen of the Case L. (seen only after death) are given in the following table:—

TABLE II.—1904.

Case.	Material from enlarged glands.			Blood.			Issue.
	Smears.	Cultures.	Inoculations.	Smears.	Cultures.	Inoculations.	
A	+	+	+	0	0	0	Recovered.
B	+	+	+	0	0	•	"
C	+	+	+	0	0	•	"
D	+	+	•	0	+	•	"
E	+	+	•	0	+	•	Died.
F	+	+	•	0	0	•	Recovered.
G	+	+	•	0	0	•	"
H	•	+	+	•	•	•	Died.
I	+	+	•	+	+	•	"
K	+	+	•	+	+	•	"
L	•	•	•	+	+	+	"
M	+	+	•	+	+	•	"

The bacteriological examination resulted in the detection of plague bacilli in all of the cases.

Material from buboes or swollen glands was examined in eleven of the cases. Smear preparations of it showed plague bacilli in ten, all confirmed by culture, and the first three of them by the positive results of inoculations performed on guinea pigs. In the other case (H) cultures only were made. They gave a growth of bacillus pestis which produced fatal plague in the guinea-pig inoculated with it.

The results of the examinations of the blood taken from the ears or fingers of eleven of the patients during life, and of material taken from the spleen of one case after death, show that six of the twelve cases (D, E, I, K, L, M) were septicæmic. Probably Case H was also of this type (*vide* clinical account), making in all seven septicæmic cases. The bacilli were not found in the blood of the other five patients.

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* d=died.

Of the seven septicæmic cases six died and one (D) recovered. The specimen of blood from Case D, which yielded positive results on culture only (the bacilli not being detected in the smears), was taken on April 25th, 1904. A second specimen, taken two days later (April 27th), gave negative results with both smears and cultures. In the interval between the two examinations the patient had received 340 ccm. of serum (Yersin). Of the fatal cases, one (H) was not definitely proved to be septicæmic (*vide supra*), and another (L) died prior to coming under observation. The other four were shown to be septicæmic during life. Two of them (I and M) died on the same day that the specimen yielding plague bacilli was taken from them; one (K) died on the next day, and one (E) on the fourth day after the septicæmic blood was taken. The five non-septicæmic cases all recovered. F. T.

26. In the nine cases which exhibited primary buboes search for points of entry of the infection resulted as shown in the table below:—

Table III.—1904.

Case.	Situation of Bubo.	Lesion of Drainage Area.
A ...	Femoral ...	Traces of flea-bites; no local reaction.
B ...	,,	Recent finger-nail scratches.
C ...	,,	Traces of flea-bites; no local reaction.
D ...	,,	,, ,,
E(d)	,,	Inflammation and pustulation of hair follicles (dirt).
F ...	,,	None.
G ...	,,	,,
I(d)	Subpectoral	,,
K(d)	,,	,, (but see note).

Note.—On reference to the account of Case K(d) above, it will be seen that the patient had cut his thumb with a pen-knife 7 days before attack; that the wound had bled on the 6th and 5th days before it; that he had dried the blood with blotting-paper at his office; that rat's dung was found in the drawer of the office-table he used; and that plague-rats were identified on the premises during search after notification of his case. If he received the infection through the wound (but I know of no experimental evidence touching possibility of infecting animals with plague by inoculation of the dung of plague-infected rats), apparently his bubo should have occurred in the axillary glands; in fact it appeared in a subpectoral gland, while the axillary glands were not tangibly enlarged. This case should be compared with that related to the Plague Commission in India by Captain H. W. Elphick, I.M.S. (Q. 9568), in which a hospital assistant who had wounded the back of his hand with a rib of a plague-corpse fell ill with plague within 48 hours afterwards, and exhibited no axillary, but a subpectoral bubo. Captain Elphick accepted the case as showing "that the bubo is not necessarily situated in the group of glands directly related to the seat of inoculation." It is worth noting that when his patient was first examined (namely about 48 hours after receipt of the injury) the scratches had quite healed, and showed no signs of local reaction. Absence of local reaction and of lymphangitis were noted in the case of K(d), and in the following also which occurred during the current year at Newcastle. Dr. L. wounded his left hand twice in making a *post mortem* examination of the body of a man who had died of plague; pure carbolic acid was at once applied to these injuries. Almost exactly 24 hours later he began to feel ill, and at the same time felt discomfort in his right axilla, where a bubo subsequently developed. This drew attention to his right hand on which a very small breach of the epithelium was discovered at the base of one of the nails. The diagnosis of plague was bacteriologically confirmed in the usual way. The wounds of the left hand seemed to give no trouble.

27. In the case of E(d) alone, then, were there visible lesions of the drainage area (as well as of other parts of the body-surface) which might have furnished points of entrance for deposited infection casually encountered; for the finger-nail scratches in Case B had an appearance of recency when they were first examined at the 72nd hour of illness—much longer, therefore, after the hour of infection—so that it is almost certain they were made after the infection had been received, and were not the point of entrance. So also the traces of flea-bites in Cases A, C, and D, were first observed at the 29th, 58th, and 72nd hour of illness (much longer after reception of the infection), and for that reason could not be conclusively regarded as points of entry. Lastly, in the 4 cases F, G, K(d), and I(d), no lesion could be found. In point of fact, any lesion of the skin which was minute, though sufficient to give entrance to the virus, had had ample time to heal before these patients fell under observation; and, in general, it is not to be expected that such a lesion should be identifiable, unless the virus had caused inflammatory changes in its neighbourhood, or unless its infliction had been attended by sharp pain, or by some other circumstance which attracted attention at the time.

28. As regards inoculation of the virus into the (damaged or broken) skin of drainage-areas by casual contact with inanimate bodies infected by wandering plague-rats, it is to be observed that while the dwelling was the place of infection in cases I(d), L(d), and M(d), who, therefore, were certainly exposed to that risk, the infection was received at places of employment in the remaining 9 cases. These 9 patients

were then shod, and, the season having been winter, were otherwise fully clothed. Case K(d), having been excepted in view of remarks made in a foot-note to Table III, it is difficult to see how the skin of the lower extremity could have been brought into casual contact with deposited infection in the cases in which femoral buboes were exhibited (*Cf.* Report, 1902, pars. 262–70.)

29. A suggestion has been made that the infection may, perhaps, be commonly received by way of the stomach, through the eating of food that has been contaminated by the excreta or by the secretions of plague-rats. It is perhaps worth while, therefore, to refer specially to the 9 persons who were infected at their places of employment, and to point out that workmen carry their dinner with them in parcels, in which it remains until eaten. It cannot be reasonably assumed that the food of these 9 patients had ever been exposed to infection, although it may have been eaten in an infected place.

30. The foregoing details (pars. 20–9) comprise not merely what was learned of each case, but all that was learned. They are complete in essential respects, and they provide a conspectus of the epidemiology of plague, although as the number of cases was but 12 no safe induction could be framed with them. They do not stand alone, however. The conclusions to which they point can be tested by reference to the 303 cases of the outbreak of 1900, to the 139 cases of the outbreak of 1902, and to the two cases of 1903; and when this has been done, it is seen that the phenomena recorded in 1904 agreed precisely with those recorded in former years. That this was so as regards the more important points is shown in the following paragraphs.

31. In the first place, the question whether these 12 patients owed their infection to cases which had preceded theirs must be examined, and with it the correlated question whether any of them communicated infection to persons with whom they were in contact during their illness. Now, the infection in Case A was not received from an earlier case—(*a*) because attack in the last preceding case dated 9 months earlier, (*b*) because absence of communication between A. and any other sick person during more than 10 days prior to his sudden attack was positively established; and (*c*) he was positively known to have worked down to the time of his attack on premises where rodents were dying in unusual number, some of which were ascertained to be infected with plague after his case had been notified. The infection in Case A, then, was not derived from any previous case in man. Nor in the 10 cases, B to L, which next followed upon it, was the infection derived either from A or from any of them. Inter-communication was positively ascertained to have been all but impossible, and certainly did not take place. The 12th patient, M(d), was exposed to L(d) during the first 36 hours of his illness; a possibility of communication of the infection from L to M consequently existed, which will be examined immediately below. It is certain, therefore, that the cause of illness in the 11 cases A to L, did not consist in infection derived from man. The inference thus suggested, namely, that direct communication of the infection from the sick was no factor in production of this epidemic prevalence of bubonic and of septicæmic plague, is shown to be sound as soon as it is tested by comparison with the experience of 1900 and of 1902. In the former year (Report, 1900, p. 32), 276 households furnished 289 cases; 266 households yielded but a single case apiece. In the latter year (Report, 1902, par. 195), 124 households furnished 139 cases; 115 households yielded but a single case apiece. These broad statements, based as they are on the observed facts of 2 outbreaks, each of which was sufficiently extensive to avoid error, and which were widely separated from each other in point of time, suffice by themselves to establish the proposition mentioned above, namely, that these outbreaks did not owe their epidemic character to direct communication of the infection from the sick. And when, as in the year under review, the circumstances of each case are examined minutely, that broad inference is found to stand the test of individual application perfectly.

32. After having shown that epidemics of bubonic and of septicæmic plague are not due to direct communication of infection from the sick, an answer to the subsidiary question, how often such communication does occur, may be sought. The three couplets constituted by cases B and E(d), D and F, L(d) and M(d), were respectively connected with two places of employment and with one residence. A *primâ facie* case for direct communication appears therefore, but it breaks down as

soon as the circumstances are examined. Thus:—B was a labourer regularly employed at a collection of bonded stores to which a wharf was attached, at both of which plague-rats were found; while E, a carman in other employment, was not attacked until 15 days after B, nor until 12 days after B had been isolated. It is not possible that E should have received infection from B. But he had been exposed to the same circumstances as B; for he had worked at the wharf during the whole of the third day before his attack, and the last observed plague-rat at that wharf had been gathered by the intelligence staff the day after he had worked there. So also, although the cases of D and F were connected with the same mill premises, the two men had never met. D was employed at the mill, while F was merely a member of the cleansing gang which entered it 6 days after D had been seized and had gone to his distant home, 5 days after he had been isolated. Communication of the infection from D to F was impossible; and again, there was here merely exposure to the same circumstances, for F was engaged with others in collecting the dead and plague rats which were found at D's place of employment. Between M(d) and L(d) there had been close communication during some part of the first 36 hours of L.'s illness. L, who was a coachman, inhabited stables attached to a large mansion; M, was the housekeeper, and lived in the house, whence she went across to the stables after L had fallen ill, to see to his wants, and she sat up with him at night during the second 24 hours of his illness. The house was not infested by rats, and it was inhabited by other people none of whom suffered. At the stables, L was known to have picked up two dead rats, and to have killed a sick rat in his bedroom above them shortly before attack; and after notification of his case, while putrid carcases were found among dunnage in the loft on which his bedroom opened, and close to its door, plague was identified in 2 rats trapped at the stables at the same time. M was exposed, therefore, not merely to L, but also to the very circumstances in which he had received his infection from some source which quite certainly was not a precedent case in man; and therefore, although the possibility of direct communication cannot be excluded, I am unable to regard it as the most probable explanation of M's case. Thus but a shadow of doubt whether in one couplet out of three the infection may not have been directly communicated from the primary case, falls on the series of 12 cases now under review. I take the opportunity of saying distinctly, however, that I am far from denying the occasional occurrence of direct communication which, indeed, not merely must be possible but has been actually observed by others in specific instances; and of pointing out that my chief concern at this time is not with the occasional causes of individual cases, but with the general, constant, causes of epidemic prevalences of bubonic and of septicæmic plague.

33. How does this part of the teaching drawn from the short series of 1904 stand comparison with the wider experience of 1900 and 1902? In the former year, 10 households out of 276, and in the latter, 9 out of 124 yielded multiple cases; and while in both years some of the secondaries might possibly have received the infection from their primaries, others of them in both years could not have done so. The evidence that this was so cannot be summarised, except at cost of depriving it of all its cogency; reference must be made, therefore, to the original records (Reports, 1900, pp. 34–6; 1902, pars. 196–207) where the circumstances of the two series referred to were described. Nevertheless, attention may be specially directed here to that important group of 7 cases (Report, 1902, pars. 199–202) which actually furnished examples of both the contingencies under discussion, in that while some of its component persons could have received the infection direct, 2 of them could not have done so, for the sufficient reason that they had left the premises before the first of the remaining 5 had fallen ill. On the 2nd and 3rd days after having left they were themselves attacked, on premises to which no suspicion of infection then or afterwards attached. It appears, then, that experience on this point also has been uniform and consistent.

34. But were the other members of the households to which these 12 patients belonged exposed to them sufficiently long after the beginning of their illness for direct communication to have taken place? The time during which such exposure continued was as follows in each case:—E(d), 17 hours; A, 30; G, 36; I(d), 51; L(d), 51 (at home till death); M(d), 52 (at home till death); K(d), 60; C, 63; B, 72; F, 96; D, 99 (part in a general ward); and H(d), 144 hours (in a general ward till death).

If with this statement, Table XII, Report, 1900, and Table XX, Report, 1902, be compared, it will be found that all are practically identical. For the most part, the infection had ample time to spread from the 396 cases thus analysed.

35. Thus, secondary cases have occasionally been observed from the beginning. In some of them direct communication was possible; in others, the clinical and other physical conditions of common kinds rendered it either extremely unlikely or even altogether impossible that direct communication should have operated. An unreserved answer to the question—how often the infection was directly communicated from the sick?—therefore, cannot be made; but at all events it is certain that this occurred very seldom at most, and that direct communication was not a factor in causation of any of these epidemics.

36. The infection did not spread directly from the sick;—might it have become diffused by indirect means, that is to say by fomites? That there had not been dissemination of articles from any of the plague-houses of 1904 before they had fallen under the disinfecter's hands is certain; and there is no reason at all for suspecting that such dissemination had taken place during any of the earlier outbreaks as could have explained the epidemic prevalence of the disease, if it be assumed for a moment that the infection can be commonly diffused by that means. Further, if it be granted, for the sake of argument, that there had been dissemination of articles from plague-houses, how could it happen that an infection which did not spread within houses by (direct or) indirect means should become capable of being spread by those same means, provided only the articles were carried outside houses? In short, nothing on this subject of importance can be added to the remarks I originally made (Report, 1900, p. 30), except that no ground for suspecting that the infection may have been diffused by inanimate mediate channels has since been seen.

Were the infection known to be communicated by fleas, then it seems possible that removal of articles outside houses might incidentally cause them to be infective, although (apparently) not so within houses. For during transport the fleas would be starved, and would seize the earliest opportunity of taking blood (*Cf.* Report, 1902, par. 284, Tidswell; Gauthier et Raybaud, Revue d'Hygiéne, XXV, p. 426, May, 1903).

37. The importance of the foregoing observations to all who are practically interested in prevention of plague cannot be exaggerated. They show that the infection was not diffused from the sick, either directly or by intermediary of inanimate bodies; yet they show at the same time that it was diffused. *Thence it necessarily follows that its diffusion was incidental to conditions which obtained independently of man.* For a clue to them, the circumstances in which the infection was received by man must be scrutinised.

38. It has been positively shown that the sole bond between Cases B and E(d) was resort to the same premises; so, also, with Cases D and F. The two premises referred to stood on the same small area within the city. It has also been positively shown that while A, C, G and K (d) were the only cases which occurred at their several dwellings, and in the separate uninfected districts in which their dwellings stood, all of them were employed within the above-mentioned area; lastly, that I(d) both dwelt and was employed on that area. It has been further positively ascertained that these latter 5 had had no communication with each other, nor any with the four former cases (B, E, D, F). It is equally certain, therefore, that the infection was not carried to E(d) or to F, and that they travelled to the infection; the same can be confidently asserted of the cases A, C, G, I(d) and K (d) between whom, also, the sole bond, besides that of their attack with an identical disease, was their resort to the same small area. Thus it appears that the infection was associated with a certain locality, and even with particular premises upon it; those alone suffered who resorted there. If this conclusion be sound, it should also follow from the distribution of cases in each of the preceding outbreaks of 1900–1902–1903. It does so. Data recorded in 1900 (Table XIII, pp. 34–35) showed that at each of 17 work-places more than one workman was attacked; the groups of cases thus formed numbered from 2 to 4, and the total number of persons comprised in them was 43. These 43 persons dwelt away from their work-places in 43 houses (which yielded but a single case apiece), and were ascertained to have had no communication with each other except at their work-places; they were also ascertained to have had no communication with any precedent case of plague. The neighbourhoods in which they lived resembled each other in having been distant from those in which their places of employment stood, but differed in that some had furnished indigenous cases of plague or plague-rats and on that ground could be regarded as infected areas, while

others had not done so. Now, in the first place, there were 2 groups, which comprised 3 and 2 persons respectively, of which all the members lived in different, uninfected, neighbourhoods; the sole bond between them was resort to the 2 places at which they worked, and which stood on an infected area. Secondly, there were 10 work-places at which 28 persons were attacked in groups of from 2 to 4 persons at each; 14 of them did, while the other 14 did not, reside in infected neighbourhoods, and each of the 10 groups included representatives of both kinds of neighbourhood. As to the 14 who lived in uninfected neighbourhoods, there was no other bond between them and the remaining 14 than resort to the same work-places; as far as they were concerned there seemed to be no room for doubt that they were infected at their places of employment and nowhere else. That being so, no reason appeared for preferring the supposition that the other 14 had become infected in some untraceable way in the infected neighbourhood in which they dwelt, rather than at the work-places which had certainly been the source of infection for the 14 first-mentioned. Lastly, 5 work-places furnished groups of 2 each, of which groups both members resided in infected neighbourhoods; from them, taken by themselves, nothing to the present purpose could be inferred. They were included in the table because it was intended to exhibit frankly all known facts of the class under examination; I now maintain them there partly because the evidence afforded by the 12 groups already analysed was so nearly demonstrative; partly, also, because the expression "infected neighbourhood" was intended to, and did, represent a mere chance which was mentioned as a precaution against omission of a circumstance of possible importance, rather than any probability of efficient infectivity towards the persons now referred to. It will appear presently, indeed, that a neighbourhood or area is not infective in general, but only in virtue of particular buildings which are infected and which stand upon it. Similar observations were recorded in 1902 (Report, 1902, par. 209, Table XXIII), though in smaller number, as well as in 1903; they had more apparent (not real) weight from the greater fulness with which the details were described. Thus the data recorded in 1900, 1902, and 1903 resembled those now recorded of 1904, and the third conclusion drawn from the experience of 1900 (Report, p. 41) is now seen to have been fully corroborated by the results of further observation during those later outbreaks. This was that the infection was associated with localities.

39. What was the nature of the association between the infection and localities in which it had been shown to exist by attack of persons who had resorted to them, but who were ascertained to have been dissociated from each other under every other aspect? The infection is living; it must be present, therefore, in or upon something which not merely permits it to survive, but enables it to flourish, for it must otherwise be confined to the spot whereon it was first deposited, which, of course, does not happen. *Quâ* localisation, its possible niduses appear to be comprised under the three headings, air, water, and soil. In the air it could not continue and, above all, could not flourish any more than other infections of like nature. By water it was not conveyed at Sydney (Report, 1900, p. 30; the reasons there given apply equally to the outbreaks of 1902 and 1904), and it is now generally agreed that by water it cannot be conveyed (*Conférence Sanitaire de Paris*, 1903, *Procès-verbaux*, p. 88; exceedingly cautious though this Conference was in expressing itself on most points, it adopted the opinion *l'eau potable ne joue aucun rôle dans la propagation de la peste* without discussion). In the earth it might live, continue, and in some sense flourish, as some members of the group of organisms which cause hæmorrhagic septicæmia (to which *b. pestis* has hitherto been generally considered to belong—the pasteurelloses) appear to do. But this has not been established for the particular micro-organism now under notice, and, without denying that it might find a place in the surface soil of cities, it must be admitted that there it would be exposed to a thousand inimical accidents. Apart from that consideration, did it grow in the soil it would probably persist in it. But the association between place and the infection at Sydney was not persistent. The uniform experience of 4 outbreaks has been that the most ordinary processes of scavenging and cleansing sufficed to banish it at once and for all.* On the whole, the observed phenomena indicate that the suggestion of association between the infection and the soil in relation to attack of man is unpractical (Cf. Reports, 1900, p. 40, or 1902, par. 263).

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* From Table V. (pp. 20, 21) it appears that some areas have become infected more than once. It is pointed out that the names which indicate them are those of extensive municipalities, and that the reinfection did not occur in the neighbourhoods previously attacked.

40. Yet cases did recur in certain localities after rather long intervals. Of the 9 places of infection recorded in 1904, 7 were situated on an area which had yielded indigenous cases 9 months earlier (1903), 12 months before that (1902), and again 15 months before that, namely, in 1900. Were these recurrences consequential or merely accidental? On comparison of Diagram I, Report, 1902, with Diagram C, 1900, it appeared that several large areas which had yielded many indigenous cases in 1900, were entirely spared in 1902. They have not since been revisited. In 1902, again, several areas were infected during the earlier part of that outbreak, at a date when they were so widely separated from the central area on which it had begun by uninfected tracts which for the most part were covered with houses, that they were plainly entitled to be regarded as seats of distinct sub-epidemics; these also have not been revisited during the 3 years since elapsed. One of those sub-epidemics, which under this aspect was complete, may be specially mentioned; I mean that distinguished as the Paddington sub-epidemic (Report, 1902, pars. 88–96, and Diagram III). The small area on which it occurred was completely isolated from any other which was then, or which previously had been, invaded; it measured only 16 acres, had 163 buildings, and carried 8 cases which occurred in 6 houses during 32 days. No special treatment was accorded to it, yet the disease has not recurred upon it. Thus it appears most probable that the 7 places of infection which occurred in 1904 on that central area which had been previously visited 3 times did not necessarily do so in consequence of those earlier visitations, for other areas to which reference has just been made were finally rid of the infection by the same measures as were applied to it. Plague is not communicated to the soil; the soil does not communicate it to man; association between a locality and the infection is a transient condition.

41. But perhaps the territorial subdivision indicated by the word "area" is too extensive. The ground on which areas have been regarded as infective has been (so far) the occurrence somewhere upon them of cases in man. At all events, then, the investigation can be carried a little further; for if any one fact of importance has been brought out more clearly than another in the course of this inquiry, it is that the infection of man has been contingent, for the most part, on his being within buildings of some sort. And therefore, although nothing has appeared which points towards infection of the surface soil, it is yet possible that the "soil" (earth, dust, surfaces of inanimate bodies, &c.) within buildings may have proved a suitable nidus for the bacillus, which may have persisted in it from outbreak to outbreak. This point has already been fully discussed in the light of experience (Report, 1902, pars. 36–44, and Diagram I). In the first place it was shown that of the 221 houses which had been adjudged to be places of infection in 1900, 215 were spared in 1902, although a majority of them stood on the same area as was invaded in the latter year. Secondly, out of 86 houses which were adjudged to have been places of infection in 1902, 80 were in that year infected for the first time. To take another aspect of the matter, 286 houses merely harboured cases in 1900 (a statement which disregards the place of infection, and takes cognizance only of the presence of cases in the houses); only 8 of them again harboured cases in 1902. But even of those 8 only 4 were adjudged places of infection in both years. Although 2 were regarded as places of infection in 1902, the patients they harboured in 1900 were then considered to have been infected elsewhere; while the remaining 2, adjudged to have been places of infection in 1900, could not be so regarded in 1902. No evidence of place-infection, by which is meant extra-corporeal persistence of the infection in efficient form during more or less long periods of time, has been revealed, therefore, by the data concerning infected houses, just as none was revealed by those concerning infected areas. The connection between the infection and individual houses is as transient as that between it and areas. But renewed invasions of any area must probably lead, in course of time, to re-infection of some of the houses upon it; and this seems to be the best explanation of the apparent infectiveness of the very small minority of 4 houses in two epidemics which were separated (it is to be additionally noticed) by so long an interval as 15 months at the least.

42. By broad induction from, I think, a sufficiently large collection of data it has been shown that the infection was not communicated from the sick by direct or indirect (inanimate) agency, *that it must, therefore, have consisted in something external to man*, that it was distinctly connected with locality, and that this connection was not persistent but transient. Consequently the source of the infection for man must be looked for elsewhere. Animated nature alone remains. Now, it is

notorious that rats and mice alone among animals are specially susceptible of plague, and at the same time habitually infest the dwellings of man. The sole questions, therefore, which remain to be answered are whether connection between plague cases and plague-rats can be positively established in a large majority of instances; and, if so, how the infection finds its way from the rat (to which animal, no doubt, it primarily belongs) to man.

43. The latter point has been considered in previous reports, and nothing of importance can yet be added. Inoculation through the skin is the mode of infection in bubonic and septicaemic plague which is best supported by the pathology of the disease. The suggestion that inoculation commonly results from accidental apposition between minute lesions of the skin and infectious matter deposited by animals has been considered to overlook practical considerations to the contrary (see Report, 1902, pars. 251–60, 261, and 298); the argument was cogent, based on experimental data and common knowledge, and it has not been answered. As regards possible inoculation by the flea, a good deal of circumstantial evidence has been adduced in this series of reports (Reports, 1900, pp. 23, 40, 56–7; 1902, pars. 262–71, 272–92, 293–4, 298–9), but nothing of a direct character; such direct evidence as has been offered by others both for and against that mode still stands much in need of examination on more exact lines. The infection of man by feeding—the only other mode which can be suggested with due regard to practical possibilities—is negatived, in my opinion, not only by the pathology but also by the symptomatology of the disease (as well as by other considerations; see par. 29 above).

44. As regards the former question it may be inquired, first, what were the time-relations between epizoötic and epidemic plague; and, secondly, by what feature were those areas on which the epidemic manifested itself distinguished from others, besides the occurrence of cases upon them. As to time-relations at least two points should be clearly made out—plague-cases should be met with only while plague-rats are present, and the beginning of the epizoötic should precede that of the epidemic. The record is set out in the table below:—

TABLE IV.—1900-4.

Year.	Month.	No. of Persons in-fected.	Rats and Mice.		Period.
			No. ex-amined.	No. in-fected.	
1900	January	1	...	...	First.
	February	3	22	9	
	March	51	12	2	
	April	107	31	6	
	May	93	48	5	
	June	41	36	1	
	July	6	24	...	
	August	1	14	...	
	September	...	7	...	
	October	...	10	...	
	November	...	6	...	
	December	...	4	...	
1901	January	...	1	...	
	February	...	21	...	
	March	...	16	...	
	April	...	9	...	
	May	...	1	...	
	June	...	1	...	
	July	...	...	...	
	August	...	157	...	
	September	...	4	...	
	October	...	...	...	
	November	1	226	4	Second.
	December	1	303	...	
1902	January	6	211	5	
	February	26	449	25	
	March	57	550	6	
	April	20	3,023	37	
	May	22	3,345	23	
	June	6	2,397	4	
	July	...	2,124	1	
1902	August	...	1,684	...	
	September	...	1,156	...	
	October	...	2,455	...	
	November	...	2,177	...	
	December	...	3,108	...	
1903	January	...	1,115	...	
	February	...	1,250	...	
	March	...	1,538	...	
	April	...	1,424	...	
	May	...	3,723	27	Third.
	June	1	5,269	97	
	July	1	4,186	23	
	August	...	3,087	14	
	September	...	3,196	...	
	October	...	3,232	...	
	November	...	3,045	...	
	December	...	2,414	...	
1904	January	...	2,565	...	
	February	...	2,483	...	
	March	1	5,808	4	Fourth.
	April	4	5,394	32	
	May	3	5,605	35	
	June	1	5,356	89	
	July	1	5,371	50	
	August	...	4,331	6	
	September	2	4,472	20	
	October	...	3,783	5	
	November	...	3,238	1	
	December	...	3,621	1	

45. This table does not show that plague in rats always preceded plague in man. Quite at beginning of the first outbreak no adequate search for plague-rats was made, and no systematic watch was kept on the rats during the 15 months which elapsed between its close and beginning of the second outbreak. During the latter, search began only after its first case had been notified, so that the position was almost the same as in 1900, when the disease first appeared here. But the ascertained facts on both of these occasions, although they did not absolutely demonstrate precedency of the epizoötic, yet furnished very good ground for assuming it. (*a*) As soon as the nature of the first case had been ascertained (25th January, 1900), the public were requested by advertisement to report any unusual mortality or movement of rats which they might have observed. No response was made until 14th February—that is to say, during the interval of 29 or 30 days which elapsed before the second patient was attacked—when a Customs Officer drew attention to mortality among the rats at the wharf where he was engaged. On search, 3 or 4 carcases were found in which the infection of plague was identified, while wide spread of it among rats along that wharf-line was ascertained immediately afterwards; and when, several weeks later, an inspector of imported fruit in employment of the Agricultural Department mentioned that he had first noticed an unusual number of dead rats at the wharf at which he worked in the same neighbourhood, as far back as the first week of January—that is to say, before attack in the first case—no other reason for doubting his account appeared than that he spoke from memory. (*b*) The first case of the outbreak of 1902 was not notified until the 10th day of illness. It was then found that the patient's place of employment yielded 69 carcases of rats, all of which but one were so far advanced in putrefaction as to be useless for bacteriological examination; from which it was inferred that the disease had attacked the horde many days earlier. So, also, search along the Darling Harbour wharf-line revealed the presence of plague in the rats there as soon as it was begun—that is, 2 days after notification of the case referred to, and thus showed that the disease was already widely spread. (*c*) Onwards from conclusion of the 1902 outbreak a systematic and thoroughly efficient watch was constantly kept on the rats, and this resulted in establishing presence of the epizoötic both in 1903 and 1904 before any human being had fallen ill.

46. The time-relations, then, may, on the whole, be taken to have been in fact what in theory was required. If, now, we proceed to examine the place-relations, it will be found that the feature which distinguished areas on which cases occurred from others which yielded none, was the presence upon them of plague-rats. The record is set out in the next table:—

Table V.—1900-4.

	First Period.		Second Period.		Third Period.		Fourth Period.	
	Cases.	Infected rodents.	Cases.	Infected rodents.	Cases.	Infected rodents.	Cases.	Infected rodents.
City of Sydney—								
Belmore Ward... ...	2	1	2	......	......	......	......	......
Bligh „	2	......	3	......	......	......	......	......
Bourke „	26	2	8	5	1	1	......	22
Cook „	8	......	1	19	......	......	......	......
Denison „	12	......	6	2	......	......	......	......
Fitzroy „	......	......	2	2	......	3	......	......
Flinders „	4	......	......	......	......	......	......	......
Gipps „	11	......	3	4	......	2	3	33
Lang „	77	13	13	24	1	64	4	143
Macquarie „	17	1	26	13	......	......	......	6
Phillip „	14	1	12	4	......	2	2	25
Pyrmont „	5	......	6	5	......	11	......	......
Suburban Municipalities—								
Annandale	4	......	......	......	......	......	......	......
Alexandria	......	......	8	4	......	......	......	......
Ashfield	......	......	......	......	......	......	......	......
Balmain	......	......	......	......	......	......	......	......
Bexley	......	......	......	......	......	......	......	......

	First Period.		Second Period.		Third Period.		Fourth Period.	
	Cases.	Infected rodents.	Cases.	Infected rodents.	Cases.	Infected rodents.	Cases.	Infected rodents.
Suburban Municipalities—*continued.*								
Botany	......	......	......	......	......	......	1	2
Botany North	......	......	......	......	......	......	......	......
Burwood	......	......	......	......	......	......	......	......
Camperdown	2	......	2	5	......	......	......	......
Canterbury	......	......	......	......	......	......	......	......
Concord	......	......	......	......	......	......	......	......
Darlington	......	......	......	......	......	......	......	8
Drummoyne	......	......	......	......	......	......	......	......
Enfield	......	......	......	......	......	......	......	......
Erskineville	......	......	......	......	......	......	......	......
Glebe	6	......	......	......	......	......	......	......
Hunter's Hill	......	......	......	......	......	......	......	......
Hurstville	......	......	......	......	......	......	......	......
Kogarah	......	......	......	......	......	......	......	......
Lane Cove	......	......	......	......	......	......	......	......
Leichhardt	1	......	......	......	......	......	......	......
Manly	10	3	......	......	......	......	......	......
Marrickville	......	......	......	......	......	......	......	......
Marsfield	......	......	......	......	......	......	2	4
Mosman	......	......	......	......	......	......	......	......
Newtown	......	......	1	12	......	......	......	......
North Sydney	......	......	......	......	......	......	......	......
Paddington	20	......	9	3	......	......	......	......
Petersham	......	......	......	......	......	......	......	......
Randwick	......	......	......	......	......	......	......	......
Redfern	25	2	1	1	......	......	......	......
Rockdale	......	......	......	......	......	......	......	......
Ryde	......	......	......	......	......	......	......	......
St. Peters	......	......	......	......	......	......	......	......
Strathfield	......	......	......	......	......	......	......	......
Vaucluse	......	......	......	......	......	......	......	......
Waterloo	10	......	10	2	......	80*	......	......
Waverley	3	......	......	......	......	......	......	......
Willoughby	......	......	......	......	......	......	......	......
Woollahra	6	......	......	......	......	......	......	......
Totals	265	23	113	105	2	161	12	243

47. Again the evidence regarding the first year is defective; it suggests that in 1900 plague occurred independently of infected rats, for many districts yielded cases rather freely from which, as it appears, no plague-rats were gathered. But failure to collect plague-rats is not ground for asserting that none existed, nor even that none could be found.

It might be thought that this point hardly could escape attention; yet it is not unnecessary to mark it. For, during the proceedings of the Technical Sub-committee of the Paris Conference, 1903, one of the delegates of Great Britain cited the cases of Glasgow (first outbreak) and of Liverpool in proof of his assertion that plague in man had occurred in places where it appeared that the rats were unaffected (Discussions: pp. 354-5). Nocht (Germany) raised the logical objection that it could not be concluded that plague-rats were absent merely because none had been found; and he descanted on the difficulty often met with in detecting them (on which I have myself had occasion to remark at length; *see* Report, 1902, par. 114 *et seq.*), even within the restricted area of a vessel. It sufficed for the occasion, but it might well have been enforced by reference to the extent of the search made. This was quite inadequate. Thus at Glasgow, "from the end of August till the middle of November, 236 rats were caught within the plague area—mostly in the neighbourhood of infected houses—and no trace of the disease was discovered in any of them." The duration of the search was apparently about 75 days; the number of rats examined was equal to a rate of about 3 a day. "Most" of them, not all, were gathered in the neighbourhood of infected houses; none were got from the infected houses themselves (Report on Cases of Plague occurring in Glasgow in 1900: by A. K. Chalmers, M.D., Medical Officer of Health, August, 1901, p. 86). Again, at Liverpool, where the first identified cases of plague were encountered about 23rd October, 1901, "the total number of rats which were examined from October to December was 150. In no case was any rat found to be infected with plague" (Report on the Health of the City of Liverpool during 1901: by E. W. Hope, M.D., Medical Officer of Health, p. 169). Doubtless the transactions of an international sanitary conference, whose members are largely preoccupied with political considerations, are not, speaking generally, the best authority on scientific questions; yet the President of the Technical Sub-committee (Commendatore Rocco Santoliquido, Italy), in which the remarks under notice were made, had formally declared that the Sub-committee was concerned solely "*d'une mise au point des notions acquises,*" (p. 228). And therefore it may be regretted that the delegate referred to should have seen fit to support his argument, "that the danger from rats is not so great as has been supposed," by the still more illogical citation of the case of Cardiff, in which no man suffered, although plague was present in the rats. Delegates of France (Proust, Brouardel, Roux, and others), and of Germany (Gaffky, Nocht), as well as those of some other Powers, were at one in declaring that the danger from rats was much greater than from man, and even in regarding it as the only danger to be seriously reckoned with; a view which I have advocated in and from the year 1900, solely on grounds furnished by direct observation. That the danger referred to has not in practice been seen to take effect quite so often, perhaps, as might have been expected *a priori*, but that it is, nevertheless, the only danger run as regards the dissemination of plague oversea, appears to me to be a more exact statement than that quoted above.

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* Gray's stables, 78; the yard of a neighbouring factory, 1; a street, 1.

But discussion of the particular question (whether plague is spread oversea by plague-rats, or otherwise) is somewhat beside the point; and it is needless to do more than mention the narrowness and inexactness of such statements as, that rats are the chief means of diffusion by sea (as distinguished from diffusion on land) or, that rats are the chief means of starting epidemics in clean places, but afterwards man becomes the chief agent in continuing them. What it is necessary to learn is whether plague owes it dissemination essentially to the rat, for thus every contingency into which plague-rats enter, or may enter, is contemplated. The view entertained by English writers on plague in India and in China is that the rat is not an essential factor in epidemics; and in the following sentence, which occurred in the Report of the Indian Plague Commission, sec. 277, the reason happens to have been very clearly given, as follows:—"It is, however, important to note that the outbreak of plague among rats has not, in all cases, been followed by occurrence of plague among men, and that explosive outbreaks have sometimes been due to causes other than spread of the infection by rats." The first of these two statements may be correct, no doubt, but its bearing on the discussion is not plain. It is not antithetical to the second statement, although the construction of the sentence makes it appear so; it stands by itself as an observation of the negative order, and, as such, is open to explanation by circumstances which in no way touch the capability of rats to spread plague, and the share therein taken by them. The second point is of a quite different character; it purports to be a fact. Whether it is so is matter of evidence. Now, while it is patent to those who have compared the epidemiological sections of the Report with the testimony on which they were based, that they derived very much of their force from the manner in which that testimony was represented in them, it is also very difficult to find anything laid before, or elicited by, the Commission, either for or against the agency of rats, which can be called "evidence," even on the most liberal interpretation of the word. Omission of an epidemiologist from the constituent members of this Commission was an oversight which seems likely to have far-reaching consequences in India.

48. The record of the first period shows, indeed, that plague was identified only in 23 rats in all. The smallness of this number was due in part to the plan of record which was then adopted, and which has since been adhered to. This was to confine the term "plague-rat" to those animals in which presence of the disease had been bacteriologically demonstrated (*Cf.* Reports, 1900, p. 39; 1903, par. 13). If findings of putrid carcases in numbers during progress of an ascertained epizoötic of plague had been taken—as, no doubt, they fairly might be taken—as valid evidence of death from plague, the strictly accurate record of the first column of the table would have assumed a very different complexion from that it actually bears. But, secondly, it was soon perceived that the meagre resources at command during that year, and the necessary concentration of attention on the then most important question whether epidemic prevalences were due to communication of the infection from the sick, would prevent the rat-search from being thoroughly carried out. However, nothing appeared to prevent a systematic attempt to carry it far enough to define the area over which the epizoötic extended; and this was done with the result of showing sufficiently clearly that the epizoötic area and the epidemic area were practically conterminous (*see* Report, 1900, Diagram B). From the Diagram just referred to it will be perceived also that the rats, which in Table V are ascribed to a particular district which there appears out of all connection with any other, may well have occurred on its border-line, and, consequently, effectively near to some district which has been entered as having furnished cases but no rats. The complement of these negative observations is furnished by the three succeeding columns of the table. In 1902 the conditions of the rat-search were much improved, and in the remaining two years became very complete; it appeared, consequently, that plague-rats could be found always on areas which yielded indigenous cases. On such areas, however, plague-rats were found in some occupied buildings which, nevertheless, yielded no case in man; sometimes, also, a whole area which at some part carried plague-rats, furnished no case in man. But such facts, frequently observed elsewhere in the case of ships, do not show that plague-rats are not the cause of plague; they show only that apparent exposure is not always effective exposure, and—as I have so often pointed out—that several circumstances which do not commonly concur are necessary to communication of the disease from rat to man.

49. So broad a local association, however, might be merely coincidental nevertheless; in order to ascertain whether it had that character it must be more closely examined. Let the localities with which Case H, and Cases L and M, were

respectively connected be first considered. These places were remote from the focus (or Darling Harbour area), and they were still further removed from each other, for while one stood about 6 miles to the south, the other stood at a rather greater distance in a northerly direction. They were thus isolated from the focus and from each other by very wide tracts, which were covered with houses in numbers which diminished gradually as distance from the focus increased, and which yielded neither cases nor rats. Local infection under such conditions is a point of so much importance that it is necessary to quote the two following paragraphs from the Report of 1902, in order to show that in these instances it was not at all exceptional:—

> 238. From some part of each of the 8 wards* into which the city proper is divided (total area, 2,880 acres; number of houses, 21,137), all of which yielded cases, and from some part of each of those 6 of the 40 municipalities comprised in the metropolitan district which yielded cases of plague, plague-rats were collected. No plague-rats were got from districts in which no indigenous cases occurred. Neither were any got from districts into which cases had been merely imported; the extent to which the search was carried in such districts is shown in the sixth column of the preceding Table.
>
> 239. With assistance of the details already given (*see* Mode of Spread, p. 18), the general indication afforded by this Table can be supported a little more directly. Thus, although Alexandria and Waterloo have a combined area of 1,830 acres, which carries 3,947 houses, the findings of plague-rats were confined exactly to those neighbourhoods in which the cases of plague were found; or, although Paddington has an area of 403 acres, which carries 4,386 houses, plague-rats were found only on that very small part (of about 16 acres, carrying 163 houses) which has been named the Paddington area, where the 9† (or 11) cases which constituted that sub-epidemic were found. Again, Camperdown covers 435 acres, and carries 1,503 houses, but plague-rats were identified only at premises in that street where the two indigenous cases of plague were met with. So also at Newtown, where the municipality covers 442 acres, and contains 4,521 houses, the only case of plague which happened there was found within half-a-dozen doors of the butcher's where a local manifestation of the epizootic occurred, and at the same date. There is good evidence, then, of close association in place between plague cases and plague-rats.

50. Clearly some special circumstance must have led to occurrence of the disease in Case H and in Cases L and M on those remote and isolated areas; and if it be asked what that circumstance was, it can be replied at once that it was the presence upon them of plague-rats, since this alone distinguished them from very extensive tracts of town land which entirely surrounded them. The reason why these two distant places carried plague-rats can also be assigned, for it is known that goods of particularly dangerous kinds were transported from infected premises at the focus to each of them. Thus the matter seems clear beyond reasonable doubt. The association between plague in man and plague in rats which has been observed to be localised on comparatively small areas, and to be confined to them, is not coincidental, but is that of cause and effect. The criterion by which infection both of areas and of buildings is to be decided in general, therefore, is presence of the disease in the rats which infest them, not in the persons who inhabit them.

51. When the form in which the infection reached these distant localities is sought, doubt begins. Plague-rats have not been detected in goods carried, or in course of being carried, to a distance by land, although, of course, rats have been commonly seen to be so carried; but plague-rats have been observed on two ships (the s.s. "Antillean," Report, 1902, pars. 50–65, and the barque "Alsterschwan," Report, 1903, par. 24). Might it have been merely deposited by plague-rats at the focus on rags, old bags, &c., and on chaff, and so have been communicated to the rats at the paper-mill and at the private residence? Perhaps; yet in view of considerations which have now been sufficiently indicated, I think not. Had the agency of the flea been removed from the region of hypothesis by the results of sufficiently numerous direct experiments, that would be as likely a form of conveyance as any other; but this has not yet been done. Actual transport of plague-rats appears to me to be the best supposition.

52. This is a convenient place at which to point out that the infection cannot have reached the premises on which the cases L and M occurred less than thirty-six days before attention was drawn to disease among the rats by attack of L, and may have been conveyed to them much earlier. I have many times pointed out that presence of plague-rats has often been observed not necessarily to entail attack of man on premises on which they have been found, and that when the infection has taken effect on man usually only a few of all those

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* Now 12.

† This number has been given as 8 in paragraph 40. The sub-epidemic consisted in 9 cases; but the sub-epidemic area carried 8 of them only, for the ninth was that of a workman who was infected upon it but who lived and lay ill at a considerable distance.

apparently exposed to it, and most usually but one of them, have suffered. And just as all in the neighbourhood of plague-rats are not attacked, so those who are to suffer do not do so as soon as they come into that neighbourhood (for another example see Case A above). This latter observation has been made by others, and often, I think, has been misinterpreted. Such an interval means nothing, in my opinion, except that the lengthy chain of circumstances on which I have so often remarked, and which seems to be necessary to infection of man, is not easily completed under the conditions which usually obtain in civilised communities. The interval which elapses between the first appearance of the disease in rats and commencement of it in man is sometimes short, sometimes long. I believe the fact to be that the necessary conjunction between several coexistent, but insulated, conditions is not brought about until instances of those conditions have so multiplied that the chances against it here and there fail altogether, and conjunction occurs. This also seems to be the explanation of the erratic incidence of the disease on persons who seem to have been equally exposed to an infection which finds in man so congenial a soil that if taken it almost always flourishes in him and, very often indeed, overcomes all his resistance speedily and kills him (on this point see also Report, 1902, par. 299).

53. But if the inference of causativeness which, I think, may be drawn from the peculiar features of the observed association between cases and plague-rats on areas be just, it should be capable of corroboration by tracing it more particularly, and by showing that it existed, not merely in relation to areas, but in relation to the individual houses in which cases occurred. As soon as the attempt to do this was made great difficulties were encountered, which have already been described at length (Reports, 1902, par. 22; 1903, par. 13); they attached in part to the search-conditions, and in part to the habits of rats. In practice it is not easy to find plague-rats; it is equally difficult to find their carcases in a state of preservation in which the presence of plague in them can be demonstrated. To overcome these obstacles was the special object kept in view during 1904.

54. The kind and duration of association with plague-rats discovered in the twelve cases has already been given above in detail, along with other particulars concerning them; but the following summary will, perhaps, make these points clearer. The word "focus" is used to indicate all that central part of the city over which infected rodents were gathered (*see* Diagram); for the value of the expression "remote from focus" reference may be made to the notes of each case (*see* paragraph 20).

A.—Attacked 9th March. Employment, at focus; had handled dead rats on three days, ending 3rd March; during search after attack 11th March, dead mice found and plague identified in them. Residence distant from focus; no signs of infestation.

B.—Attacked 10th April. Employment, at focus (Grafton Bonded Stores); at one or other of the collection of separate buildings at which B worked plague-rodents were identified as follows:—1st March, 14th, 18th, and 20th April (on the adjoining wharf), 27th April, 14th and 31st May. Residence distant from focus; no signs of infestation.

C.—Attacked 20th April. Employment, near focus; a plague-rat had been identified 19th April, and others were identified during search at time of notification. Residence distant from focus; no signs of infestation.

D.—Attacked 22nd April. Employment, at focus (Wearne's Grist Mill); plague-rats identified on search, after notification, 27th April to 5th May. Residence remote from focus; no signs of infestation.

E.—Attacked 25th April. Employment, near focus; no dead rats found, no plague-rat identified; but on 22nd April had loaded goods at Grafton Wharf, whence plague-rats had been taken on 14th, 18th, and 20th April (see B, above). Residence not far from focus; no signs of infestation.

F.—Attacked 8th May. Employment, at focus (member of cleansing gang); plague-rats identified at D's place of employment (Wearne's Grist Mill, see D, above) which F had helped to cleanse between 28th April and 5th May. Residence at focus; no signs of infestation.

G.—Attacked 25th May. Employment, at focus; plague-rats identified before attack, G. having handed in two dead rats on 24th and 25th May, as well as afterwards during search. Residence separated by water from focus; no signs of infestation.

H.—Attacked 31st May. Employment, remote from primary focus; plague-rats identified on search after notification, 10th to 23rd June. Residence remote from primary and from this secondary focus; no signs of infestation.

I.—Attacked 19th June. Employment at focus; no signs of infestation. Residence at focus; plague-rats identified 14th June, many putrid carcases found on search afterwards.

K.—Attacked 31st July. Employment at focus; plague-rats identified on search after notification, 4th to 8th August. Residence, remote from focus; no signs of infestation.

L. and M.—Attacked 7th and 10th September. Residence, remote from primary focus; on search after notification, dead rats found and plague-rats identified 12th to 16th September.

55.

55. Thus close association with plague-rats was shown to have existed in every one of the series of cases which constituted the outbreak under review; and given an experienced staff and the requisite leisure, I see no reason for doubting that a similar result would be generally attained. But neither directors nor staffs can, as a rule, afford to give the necessary watchful attention from day to day to each case as it arises, nor spare time for lengthy enquiries into details; yet these must always be indispensable conditions of success. Even when they have been fulfilled, the result can rarely be complete. In any considerable series of investigations of the kind defects must occur from time to time; and, indeed, one such was met with last year, when a minute enquiry appeared to exclude every source of infection in Case A (Report, 1903, par. 19). But no one accustomed to epidemiological work would lay much stress on negative observations of that class after having given them due consideration, as long as they remained in a proportionately small minority.

56. I am now able, therefore, to redirect attention to the eleven deductions which I drew from the first outbreak, and to point out that they remain substantially unaltered. They represented the main features of epidemic plague at Sydney quite correctly; and as in these days mere speculative opinion tends more and more to overlay the results of observation, and the chronology of events in any case is likely to be overlooked, I shall be excused, perhaps, if I remark that the total inefficiency of communication with the sick as a cause of epidemics of bubonic and of septicæmic plague, together with its all-important corollary that the source of infection must exist quite outside, and independently of, man, was first established five years ago in my account of the outbreak of 1900, on evidence which was furnished by a sufficiently long series of cases. The deductions referred to were the following:—

1. *The disease was not directly communicated from the sick to the well—in other words was not "catching."*

2. *It was not communicated in any important degree, at all events, from the sick to the well by mediate channels (clothes, household goods, merchandise, excreta).*

3. *The infection attached to localities, and spread to others adjoining and continuous with that in which it was first manifested.*

4. *It also spread in a fashion which betokens the possibility of its being transported mechanically from an existent focus to a considerable distance, and there initiating an independent focus.*

5. *In the buildings in any infected locality cases occurred irregularly, and showed no special proneness to occur in adjoining houses.*

6. *When the occurrence of one case among the inhabitants of a building showed that the infection was present in it, secondary cases rarely followed. Irregularity of incidence on houses was accompanied with irregularity of incidence on the inmates.*

7. *An epizoötic disease among rats preceded the first case which occurred in man.*

8. *This epizoötic disease was plague.*

9. *The area over which the epizoötic extended was practically coextensive with that on which cases of plague in man were observed.*

10. *The epizoötic died out as far as can be learned at the same time as the epidemic ceased.*

11. *The epidemic was caused by communication of the infection from rats to man.*

57. The aetiology of plague must be essentially the same everywhere. Individual cases of an inoculable disease may have their origin in many different circumstances, but epidemic prevalences must be due to similar causes wherever they may occur. The behaviour of the intermediary between rat and man, which latter though still hypothetical is also still indispensable, may give rise to slight variations; but these, when they come to be fully understood, will be found to have been apparent rather than real. The rat is the *fons et origo* of infection. That this view should speedily receive support from further exact observations recorded elsewhere is not to be expected. In many other countries where plague exists, conditions of race and creed, of customs and civilisation, of housing, morals, and instruction, notoriously have rendered accurate and complete epidemiological observation impossible; save, indeed, when the conditions of search have been

entirely under the investigator's control, and when completeness of result has depended solely on his personal energy. No doubt this is the case sometimes as, for instance, with malaria under some of its aspects; but it is not so with plague. The evidence which has been adduced in this series of Reports began to be collected originally under very advantageous conditions, which have improved with experience and with better instruction of the public in this particular connection; the record is as accurate, and—a not less important point—as complete as the nature of such enquiries leaves possible. I point to it, therefore, as showing that the view mentioned holds good at Sydney; and I suggest that what is constant in one large city must probably have general application.

J. ASHBURTON THOMPSON.

[One plan.]

Sydney: William Applegate Gullick, Government Printer.—1905.

L ① 36● M ⓜ
6 miles West

ⓓ
9 miles West

Table showing the places at which, and the first and last dates on which, plague-rats were taken; the entries are consecutively numbered in accordance with the dates on which they were first taken. References to the twelve cases are inserted in the series in their order, according to date of attack.

No.	Place.	Rodents taken.				First.	Last.
		Total.	M. Dec.	M. Rat.	M. Mus.		
1	Grafton Bonds, Sussex Street	4	1	1	2	1·3·4	31·5·4
	Case A, attacked 9.3.4.						
2	161 Sussex Street	1	—	1	—	9·3·4	9·3·4
3	157 Sussex Street	2	—	—	2	11·3·4	11·3·4
	Case B, attacked 10.4.4.						
4	Grafton Wharf	3	3	—	—	14·4·4	20·4·4
5	Reid's Store, Belmore Markets	24	24	—	—	19·4·4	23·4·4
	Case C, attacked 20.4.4.						
	Case D, attacked 22.4.4.						
	Case E, attacked 26.4.4.						
6	Wearne's Mills, Dixon Street	4	—	2	2	27·4·4	3·5·4
7	18-22 Campbell Street	1	—	—	1	28·4·4	28·4·4
	Case F, attacked 8.5.4.						
8	S.S. "Illawarra," Market Wharf	5	5	—	—	10·5·4	11·5·4
9	77 York Street	2	2	—	—	11·5·4	12·5·4
10	A.U.S.N. Wharf, Nos. 4 and 3	4	2	1	1	12·5·4	3·12·4
11	227 Sussex Street	1	1	—	—	16·5·4	16·5·4
12	257 Sussex Street	2	—	—	2	20·5·4	20·5·4
13	235 Sussex Street	1	1	—	—	23·5·4	23·5·4
14	46 City Road, Darlington	2	2	—	—	24·5·4	26·5·4
	Case G, attacked 25.5.4.						
15	Federal Wharf, Bond Yards and Stores	28	17	2	9	25·5·4	28·7·4
16	Dalgety's Wharf (Old), No. 1	12	2	6	4	25·5·4	24·6·4
17	Town's Wharf	4	3	—	1	26·5·4	14·6·4
18	45 City Road, Darlington	6	6	—	—	26·5·4	28·5·4
	Case H, attacked 31.5.4.						
19	7 Wharf Street	11	—	5	6	7·6·4	9·7·4
20	123 Sussex Street	9	—	2	7	7·6·4	13·7·4
21	Federal Paper Mills, Botany	2	—	1	1	10·6·4	16·6·4
22	5 Wharf Street	1	—	1	—	16·6·4	16·6·4
23	H. Parker's Wharf (Goods)	1	1	—	—	18·6·4	18·6·4
	Case I, attacked 19.6.4.						
24	9 Wharf Street	55	1	42	12	24·6·4	1·7·4
25	Union Wharf, Druitt Street, No. 2	1	—	1	—	4·7·4	4·7·4
26	129 Sussex Street	4	—	—	4	11·7·4	26·7·4
27	China Wharf	1	1	—	—	20·7·4	20·7·4
28	Goldsbrough, Mort's Store, Circular Quay	22	22	—	—	25·7·4	29·7·4
	Case K, attacked 31.7.4.						
29	170 Clarence Street	3	—	2	1	4·8·4	8·8·4
30	Dalgety's Wharf (New), Nos. 2, 3, and 1	4	3	—	1	25·8·4	23·9·4
31	153 Sussex Street	1	—	1	—	26·8·4	26·8·4
32	Harbour Trust's Lumber Yard	1	1	—	—	3·9·4	3·9·4
	Case L, attacked 7.9.4.						
33	61-63 Sussex Street	2	—	1	1	8·9·4	8·9·4
34	Dalton's Wharf, No. 1	1	—	—	1	9·9·4	9·9·4
35	69 Sussex Street	1	—	—	1	9·9·4	9·9·4
	Case M, attacked 10.9.4.						
36	"Curzon Hall," Balaclava Road, Marsfield	4	—	3	1	13·9·4	17·9·4
37	408 George Street	2	2	—	—	14·9·4	30·9·4
38	150 Sussex Street	1	—	1	—	15·9·4	15·9·4
39	Dalgety's Wharf, Nos. 1 and 2	4	2	—	2	24·9·4	11·10·4
40	Cellar of Sydney Arcade, George Street	4	4	—	—	29·9·4	4·10·4
41	363 Sussex Street	2	2	—	—	10·10·4	10·10·4
	Totals	243	108	73	62		

PREPARED FOR THE DEPARTMENT OF PUBLIC HEALTH.

MAP OF THE

CITY OF SYDNEY

AND

ADJACENT MUNICIPALITIES.

SCALE

THIS DIAGRAM SHEWS THE PLACES AT WHICH PLAGUE-RATS WERE TAKEN DURING 1904, THE PLACES AT WHICH PERSONS WHO HAD PLAGUE WERE EMPLOYED, AND THE PLACES AT WHICH THEY RESIDED.

EXPLANATORY NOTES.

Places at which plague-rats were taken—consecutively numbered in accordance with the date on which the first was taken at each place — shewn thus — ●22
Places at which persons who had plague were employed — do — A
Do do do resided — do — ⓐ
Boundaries of the Wards into which the City proper is divided — do — - - - - -

J. Ashburton Thompson
7th July, 1905.

ⓚ 1¼ mile

21● H 4½ miles South

57956

Photo-lithographed by
W. A. Gullick, Government Printer,
Sydney, N.S.W.

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NEW SOUTH WALES.

REPORT

OF THE

BOARD OF HEALTH

ON

PLAGUE IN NEW SOUTH WALES, 1905.

On a Fifth Outbreak of Plague at Sydney, 1905.

BY J. ASHBURTON THOMPSON, M.D., D.P.H., PRESIDENT,
Chief Medical Officer of Government.

On Outbreaks of Plague on the Clarence and Richmond Rivers, 1905.

BY R. J. MILLARD, M.B., CH.M. (SYD.), D.P.H. (CAMB.),
Assistant Medical Officer of Government, and Assistant Microbiologist,

On an Outbreak of Plague at Newcastle, 1905.

BY ROBERT DICK, M.B., CH.M. (SYD.), D.P.H. (CAMB.),
Medical Officer of Health, Hunter River Combined Districts.

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[With Five Maps and one Chart.]

REPORT OF THE BOARD OF HEALTH

ON A

FIFTH OUTBREAK OF PLAGUE AT SYDNEY, 1905.

By J. ASHBURTON THOMPSON, M.D., D.P.H., President,
Chief Medical Officer of Government.

During the outbreak of 1904, a special effort was made to ascertain whether close connection between cases and plague-rats could not be established in every instance provided sufficient time were devoted to the search; and it was made with reference to two points. One was the difficulty, thought to be merely incidental, which had so often prevented demonstration of the presence of plague-rats on premises which had proved themselves to be infective, and the consequent incompleteness of the evidence which in general supported the view that rat-plague is a condition precedent of plague in man. The other was the desirability of examining more exactly into cases where it was thought, after due search, that neither rats nor signs of infestation by rats were present, which had appeared to have been the case in a very few instances; in which, nevertheless, presence of plague-rats in the immediate neighbourhood had been ascertained. However, while only 12 cases occurred in connection with 9 places of infection, the presence of plague-rats at each place was established, so that no opportunity of further examining the second point then offered.

2. As far as it went, that evidence was against the soundness of the observation which had been made, namely, that very rarely a house might prove to be a place of infection in absence of signs of infestation by rats; still, the point has been noted for further inquiry. But although in the year referred to the number of cases and of places was extremely small, it had been found that the labour involved in the constant watchfulness of all concerned, which turned out to be necessary to success, and of long quasi-detective enquiries, were too great to be continued by a staff whose daily avocations were multifarious and exacting. During the year now reported upon, therefore, no special attempt was made to run the plague-rat down in connection with every case, although the more salient points were as carefully recorded as usual.

3. The last case in 1904 had occurred on 10th September, and the last plague-rat had been identified on 3rd December. The continuous examination of rats, which began with the outbreak of 1901–2, having been maintained steadily since then, the first plague-rat in 1905 was identified 18th January. The date of attack in the first case of 1905 was 11th March, and in the last case of that year it was 12th July. The last plague-rat was identified on 5th December. The number of cases was 18, of which 5 were fatal; they were met with in connection with 18 dwellings (*see* cases E and G; G moved house after having been infected at E's dwelling.)

4. The period which it is necessary to review extended from 4th December, 1904, to 31st December, 1905, and may be divided as follows:—The precedent plague-free term lasted from 4th December, 1904, to 17th January, 1905; the epizootic period from 18th January to 5th December; and the subsequent plague-free period from 6th December to the end of the year. This latter period, it may be noted here, lasted only 49 days, the first plague-rat of 1906 having been taken at the Baltic Wharf, Darling Harbour, on 23rd January.

5. During the precedent plague-free period, 4th December to 17th January, the Intelligence Staff delivered 3,142 rats, 1,944 mice ; total, 5,086. All of them were examined in the laboratories, and none were infected with plague.

6. During the epizoötic period, 18th January to 5th December, the Intelligence Staff delivered 14,897 rats, 13,549 mice, total 28,446, all of which were examined, and among which plague was identified in 123 rats and 18 mice, total 141. Additionally, 3 other animals were referred for examination, namely, 1 domestic cat, 1 native cat (*Dasyurus viverinus*, Shaw), and 1 kangaroo-rat (*Æpyprymnus rufescens*, Gray). All were found to be free from infection with plague. This period commenced with discovery of plague-infected specimens of *M. rattus* at the North Coast Steamship Company's Wharf at Darling Harbour, and at a later date of *M. decumanus*. They had, perhaps, been reimported from one of the infected spots on the Northern Rivers to which the infection had probably been communicated from Sydney towards the end of the preceding year, or (in the case of one town) from another infected State (*see* Report on Plague on the Northern Rivers, *infra*). The meaning attached in this series of reports to the word "identified" should be borne in mind. Many other rats which were reasonably believed to have died of plague, but which were too advanced in putrefaction for bacteriological examination, were brought in or observed ; still, were these added, the total thought to have died of plague would still bear but a small proportion to the total taken. It is considered that a proportion (which may be considerable) of the carcases of rats which have died of plague never come to light.

7. During the subsequent plague-free period, which extended from 6th December to the end of the year, the Intelligence Staff brought in 956 rats, 552 mice, total, 1,508, all of which were examined and found to be plague-free.

8. The number of rats destroyed during the whole year—that is, from 1st January to 31st December—was 52,027 rats, 39,092 mice ; total, 91,119. A reward for the carcases of rats and mice was again offered to the public, and was paid from 1st April to 31st October. The numbers paid for were 34,963 rats, 24,261 mice ; total, 59,224. None of them were examined. The number brought in by the Intelligence Staff during the whole year was—rats, 17,064 ; mice, 14,831 ; total, 31,895.

9. The species of rodents brought in by the Intelligence Staff during the whole year, and their respective numbers, were as follows :—*M. decumanus*, 11,383 ; *M. rattus*, 5,681 ; *M. musculus*, 14,831. The percentages of each to the total were :—*M. decumanus*, 35·68 ; *M. rattus*, 17·80 ; *M. musculus*, 46·49.

10. During the epizootic period alone, the numbers of each species in which plague was identified were—*M. decumanus*, 78 ; *M. rattus*, 45 ; and *M. musculus*, 18 ; and the percentages of infected specimens to the total of each species examined during this period were respectively ·79, ·88, and ·13, which were practically the same as the proportions noted in former years.

11. The following abstracts exhibit the salient features and circumstances of each case :—

CASE A.

H.E., m., æt. 22, single, labourer ; no former attack ; not inoculated ; no communication with any previous case. Residence, 47, Gipps-street, Balmain ; employment, McDonald's produce store, Harbour-street, Darling Harbour ; last at work, 11th March. Attack, 11th March, sudden, about 7 a.m. ; first sign, pain in bubo of left femoral region ; the swelling must have begun previously. Notified by Dr. Shirlow, 11·30 a.m., 16th March ; visited (F.T.) 12·30 ; admitted to Coast Hospital, 6 p.m. ; discharged, 20th April ; duration of illness, 40 days. Material from bubo, 16th March ; films, indefinite ; cultures, positive ; inoculation (guinea-pig), positive. Lesions of drainage-area, one or two small scabs, and flea-bites.

Rats.—At residence, none ; at employment, 4 living, 6 dead, rats ; 4 living, 1 dead, mice ; plague not identified.

Connected Cases.—None.

CASE B.

C.L., m., æt. 47, single, caretaker ; no former attack ; not inoculated ; no communication with the previous case. Residence (concealed by patient, but traced to), Empire Club, 219, Castlereagh-street ; last there, not known. Attack, 2nd April, evening ; admitted to Sydney Hospital, 3rd April, 10 p.m ; notified thence by Dr. Corbin, 5th April, 9·30 a.m. ; visited (R.J.M.), 10 a.m. ; admitted to Coast Hospital, 2 p.m. ; discharged, 13th May ; duration of illness, 41 days. Bubo, none present 3rd April ; present, 4th morning ; left femoral region ; material from bubo, 5th April, films, positive. Lesions of drainage area, none.

Rats.—Residence and place of employment were the same ; no rats could be found. (Before the place—which was a low gambling club—could be traced, the proprietors had taken great pains to cleanse it and place it in good order.)

Connected Cases.—See J.A., a rat-catcher, with whom C.L. was friendly.

CASE C.

Case C.

E.O'R., f., æt. 44, widow, laundress. No former attack; not inoculated; no communication with any previous case. Residence, 40, Bathurst-street, city; employment, Tyne Laundry, Manly, a suburb 7 miles from residence, reached by water; last employed, 4th April. Attack, felt ill 3rd April, but went to work; went also on 4th, but could hardly work; 5th, was too ill to get up; on 6th a slightly enlarged left femoral gland was present; smears positive; no lesions of drainage area. Notified by Dr. G. H. Taylor, 6th April, 2·30 p.m.; visited (R.J.M.), 3 p.m.; admitted Coast Hospital, 6 p.m.; discharged to the general division of the hospital, 19th May; duration of illness, 46 days.

Rats.—One plague-infected mouse at residence, which was next door to a 12-stall stable, where dead rats and mice were found.

Connected cases.—*See* Case G.

Case D.

A.P., m., æt. 22, single, wharf-labourer. No former attack; not inoculated; no communication with any previous case. Residence, 8, Starling-street, Rozelle; employment, various wharfs on Darling Harbour; last there (Grafton Wharf), 24th March; attack at 10 a.m. on that date, but finished his work; not notified as plague; admitted to Coast Hospital in ordinary course, 28th March, 7·30 p.m.; died, 20th April; duration, 27 days. Cultures and inoculation made from a boil just below a carbuncle on left upper arm, positive; there were many other boils elsewhere. Plague was not suspected on admission in this case, which seemed to be one of septic infection, till a large glandular swelling made appearance on right side of neck 9th day of illness, and a smaller swelling on left side; but material taken from the former yielded only streptococci and staphylococci, and a guinea-pig inoculated with it remained well; afterwards, the skin manifestation, which had first appeared 30th March, was examined, with the positive result mentioned.

Rats.—At residence, none; slight traces of mice. At Grafton Wharf no plague rats were found; but patient had not been exclusively employed there, and his history could not be completely ascertained. (*See* Plan.)

Connected cases.—None.

Case E.

J.A., m., æt. 48, single, Departmental rat-catcher. Former attack 13th July, 1900; was inoculated (Haffkine) 10th Aug., 1903; conveyed Case B to Sydney Hospital as friend, 3rd April. Residence, 133, Dowling-street, Woolloomooloo; employment, various infected places; has brought in several plague rats; last employed, night of 7th April. Admitted Coast Hospital, 8th April, discharged 16th May, duration 40 days. Attacked 6th April, slight pain left groin; 7th morning felt unwell and was examined (R.J.M.) while delivering his rats; T. 100, otherwise normal, but left femoral gland slightly enlarged and tender; a very definite track of lymphangitis was traced back to a small suppurating sore on lower third of the leg, said to be of two or three days standing. Was again examined 8th April, morning, T. 102·4, P. 114; the sore then presented a small vesicle, in which no *B. pestis* were found by direct examination. Cultures and inoculations made with it yielded positive results, as also did material from the bubo, both taken 8th April.

Rats.—During the twelve days, 27th March to 7th April, patient had handed in plague rats or mice on nine of them; the last, a mouse, on 6th April; the last rat on 3rd April.

Connected cases.—Was associated with Case B at night, 3rd April.

Case F.

A.L., m., æt. 11. No former attack; not inoculated; no communication with any previous case. Residence, 253, Kent-street, City; attends Fort-street State School; also sells newspapers, chiefly on local steamboats, and thus frequents wharfs at Darling Harbour. Notified by Dr. G. A. Marshall, 10th April, 3 p.m.; visited (R. J. M.) 3·45; admitted to Coast Hospital 9 p.m.; died 23rd April; duration 14 days. Attack, 9th April, 3 p.m.; first symptoms, headache and pain in left femoral region, where bubo material taken 10th, culture positive. Lesion of drainage area; a hyperæmic spot on left patella.

Rats.—At residence none found; six rat-holes; some rooms infested with bugs and fleas.

Connected cases.—None.

Case G.

J. O'R., m., æt. 15, street-cleaner, employed by City Council. No former attack; not inoculated; son of E. O'R., Case C, with whom he lived till her admission to hospital. Residence, 14, Steam Mill street, Darling Harbour; employment, in streets; last employed about 1st April. Notified by Dr. Corbin from Sydney Hospital on 13th April, where he had been admitted same day; visited (R.J.M.) 14th, 9·30 a.m.; not removed; discharged 25th April; duration about 17 days. Attack: about 1st April, while living in Bathurst-street, where his mother was attacked 3rd April; had severe ear-ache, which was soon relieved, but deafness remained; on 6th was first employed as street cleaner; on 8th noticed pain in right side of neck; on 13th was admitted to Sydney Hospital, with T. 101, P. 100, R. 24, but all were normal next morning. On examination, he did not seem ill; in posterior triangle of neck, right side, were several slightly enlarged and tender glands, the largest being the size of a small marble and situated under the trapezius. Material taken from it showed nothing in film; culture of it on agar yielded an involuted bacillus which did not morphologically resemble *B. pestis*; an agar subculture from this yielded no growth, but a serum subculture yielded a fairly copious growth identical with that from which it was made. A guinea-pig inoculated from the culture died on the 5th day, and exhibited typical lesions of plague; films made from internal organs showed enormous numbers of *B. pestis*, and the latter was recovered from them by cultivation. This result was attained on 25th April; on inquiry at the hospital it was found the patient had been discharged well that morning.

Rats.—At residence (40, Bathurst-street.) *See* Case C.

Connected cases.—*See* Case C.

Case H.

S.H., m., æt. 24, single, wood-worker. No former attack; not inoculated; no communication with any previous case. Residence, 8, Fredburt-street, Leichhardt; employment, Saxton and Binns' timber-yard, Blackwattle Bay, City; last employed, 15th April. Notified by Dr. Shirlow, 15th April, 8 p.m.; visited (R.J.M.), 20th April, 9·30 a.m.; admitted to Coast Hospital 5 p.m.; discharged 16th June; duration, 57 days. Attack: 16th April, shivering, headache, and general pains after having gone to sleep aroused him; 17th, early morning found a painful swelling in right groin; vomited occasionally 17th, 18th, and 19th; on latter date at 6 p.m. had a convulsion. Bubo, right femoral; material taken 20th, films and cultures positive. Lesions within drainage-area, none.

Rats.—At residence, no signs; at employment it was reported by the proprietors that there had been many, but that they had rather suddenly disappeared about a week ago. Two rat-catchers detailed to these premises trapped but a single rat in the course of a week.

Connected Cases.—None.

Case I.

L.K., m., æt. 29, single, carter. Not inoculated; no former attack; no communication with any previous case. Residence, 21, Rose-street, Darlington; employment, 39, Boundary-street, Redfern, a produce store kept by his brother; frequently visited Darling Harbour wharves, and fetched corn or chaff from Union Wharf on 13th, North Coast on 14th, and Union on 17th. Notified by Dr. Gordon Craig, 20th April, 3 p.m.; visited (W.G.A.), 4 p.m.; admitted to Coast Hospital, 21st April; discharged, 19th May; duration, 32 days. Attack: 17th April, noon; fever, headache, and a bad cough. On examination, a small right femoral bubo (very tender), and two inguinal glands slightly enlarged (hardly tender); films and cultures from femoral and from an inguinal gland, both positive. Lesion of drainage area: a small cicatrix on the sole of the right foot left after extraction of a thorn by patient on 17th April.

Rats.—At residence, no signs; at employment, signs of recent infestation; one live rat caught, which was plague-free. The last preceding plague-rat at North Coast Company's wharf had been taken 11th March.

Connected Cases.—*See* Case K.

Case K.

T.K., m., æt. 40, married, produce dealer. Not inoculated; no former attack; connected with preceding Case I. Residence and employment as in Case I, but was employed at the store. When L.K. fell ill, he took up his work on 17th April, and collected produce from Union Wharf 18th, and from North Coast Wharf 19th April. Notified by Dr. Gordon Craig, 23rd April, 2 p.m.; visited (W.G.A.), 3 p.m.; admitted to Coast Hospital, 23rd April; discharged, 19th May; duration, 30 days. Attack: felt tired on rising 21st April, and had stiffness in left groin; towards night became feverish. Bubo in left femoral chain, size of a pigeon's egg; tender, not painful; lesions of drainage area, none; on 25th, films made with material from bubo, negative: cultures positive.

Rats and Connected Case.—*See* Case I.

Case L.

R.H., m., æt. 18, single, labourer. Not inoculated; no former attack; not connected with any other case. Residence, 69, Derwent-street, Glebe; employment, a wood and coal yard at 86, Abercrombie-street, City, making up orders for despatch; does not leave these premises during work. Notified by Dr. R. Bohrsmann, 24th April, 7·20 p.m.; visited (R.J.M.), 25th, 9·30 a.m.; admitted to Coast Hospital, 3 p.m.; discharged, 29th May; duration, 36 days. Attack sudden, 23rd April, 4·30 p.m.; severe pain in back and right groin; no sleep at night; slightly delirious. On examination large right femoral bubo which fills Scarpa's triangle, in which three or four glands can be distinguished, extremely tender; some deep tenderness above Poupart's ligament; lesions of drainage area, a small round hyperæmic patch on anterior aspect of thigh just below the anterior superior iliac spine. Material from bubo, taken 25th April, films and cultures positive.

Rats.—At residence, signs of infestation, 1 nest, 1 live rat, 1 putrid carcase; a stable, no rats; 1 putrid carcase in yard of No. 71; no rats at produce store near by, where feed for horse purchased. At Abercrombie-street, no sign of infestation.

Connected Cases.—None.

Case M.

J.C., m., æt. 28, married, ship-painter. Not inoculated; no former attack; no communication with any preceding case. Residence, Davidson-street, Balmain; employment, Adelaide S.S. Co.'s works, Nicholson-street, Balmain. Last employed, 25th April, cleaning and painting s.s. "Ouraki." Notified by Dr. Carruthers, 26th April, 8·30 p.m.; visited (R.J.M.), 27th, 10 a.m.; admitted to Coast Hospital, 5 p.m.; discharged, 31st May; duration, 36 days. Attack: 24th April, headache during the evening; 25th, felt ill on rising; went to work; gave up after two hours; at mid-day, pain in left axilla began; delirious at night; 26th, pain in axilla increased and was severe, headache slight, no vomiting; 27th, on examination, general fulness of axilla, an enlarged and very tender gland beneath border of pectoralis major, and another which could be just made out behind it; clear lymph withdrawn by needle; films and cultures negative; further material taken 29th April; cultures positive; lesions within drainage area, none.

Rats.—At residence, no signs; at employment, the works in general presented no signs of infestation, but there was plenty of harbourage for rats among lumber, &c. Quiet inquiry among the employees elicited information that during cleansing and painting of the "Ouraki's" forepeak, where the patient was employed, about 24 dead rats had been collected. The Departmental rat-catcher turned out 10 more carcases, and trapped 2 live rats; the latter were plague-free, the former too putrid for bacteriological examination; and ultimately no plague-rats were identified, either from this vessel or from the works (12 live rats altogether were taken from the vessel and examined).

Connected Cases.—*See* Case N.

Case N.

CASE N.

F.L., m., æt. 44, married, labourer. Not inoculated; no previous attack; employed on same ship as J.C., Case M. Residence, 19, Theodora-street, Balmain; employment, Adelaide S.S. Co.'s works, Nicholson-street, Balmain. Last employed, 4th May, on the s.s. "Innamincka"; 3rd May, s.s. "Innamincka" and "Adelaide"; 2nd May, on s.s. "Mintaro" and the wharf; 1st May, in bunkers of the "Ouraki"; 29th April, in limbers and holds; 28th to 25th April, on deck of forepeak. Notified by Dr. Carruthers, 5th May, 9 a.m.; visited (R.J.M.), 10·15 a.m.; admitted to Coast Hospital, 4 p.m.; discharged 31st May; duration, 28 days. Attack: 4th May, felt heavy on waking; went to work; pain in right groin at 10 a.m.; ceased work at 2·30, having apparently become extremely weak, since his fellow-workmen gave him whisky before he could leave for home; at night, rigors, feverish, bad headache, light-headed; 5th, on examination, three oblique inguinal glands enlarged, very tender, some periadenitic effusion; films and cultures positive; lesions within drainage area, none.

Rats.—At residence, no signs; at employment, *see* Case M.

Connected Cases.—*See* Case M.

CASE O.

E.O., f., æt. 40, married, dressmaker; last employed, 10th May. Not inoculated; no former attack; not connected with any previous case. Residence, 101, Moncur-street, Woollahra; employment, 38, Elizabeth street, City. Notified by Dr. Johnson; visited (T.W.S.), 13th May, noon; admitted to Coast Hospital, 13th May; discharged, 9th June; duration, 38 days. Attack, 2nd May, 7·30 p.m.; pain in right groin, shivering, headache, but swelling in groin first noticed by patient, 5th; the same symptoms continued, but she supervised her shop till 10th, when she was obliged to give up. On examination exhibited a tender inguinal gland the size of an almond; lesion of drainage area, none; films and cultures made with material taken 13th May, both positive.

Rats.—At residence, signs of recent infestation in rat-holes and fresh droppings, one carcase found, too putrid for examination; at employment, no signs. The fence at bottom of patient's yard is also the back fence of Lynch's dairy premises, on which many plague-rats were found.

Connected Cases.—None.

CASE P.

B. de G., m., æt. 34, married, furniture dealer. Not inoculated; no former attack; no communication with any other case. Residence, 49, Underwood-street, Paddington; employment, 121½, Castlereagh street, City; last employed, 13th May. Notified by Dr. Walton Smith, 15th May; visited (T.W.S.), 2 p.m.; admitted to Coast Hospital, 7 p.m.; discharged, 13th June; duration, 31 days. Patient was extremely deaf, and his memory apparently not good; but the following account was got with assistance of his brother, and of the Medical Officer of Health, Newcastle:—For some days prior to 5th May he had been employed at a furniture shop, 199–205, Hunter-street, Newcastle, and on that day was watching cleansing operations necessitated by discovery of a large number of plague-rats on those premises; the same night he returned to Sydney. On 9th May he attended a lodge meeting, and during the evening he became so ill he was obliged to go home—headache and extreme general malaise. He was a little better 10th, and went about his business, though feeling ill; on 13th, the headache and general malaise returned somewhat severely during the evening; 14th, had much nausea, vomited once, and during the day felt pain in the left groin; on examination, 15th, a left femoral gland was found slightly enlarged and rather tender; lesions of drainage area, none; films and cultures, positive.

Rats.—At residence, few traces, none present, no carcases; search of neighbourhood failed to raise suspicion of plague; the house was a mile distant from Moncur-street. At employment, few traces. (*See* Case O.)

Connected Cases.—None.

CASE Q.

P.F., m., æt. 20, single, grocer. Not inoculated; no former attack; no communication with any other case. Residence, 136, Oxford-street, Paddington; employment, 277, Sussex-street, Darling Harbour; last employed, 20th May. Notified by Medical Superintendent (Dr. Corbin), Sydney Hospital, 23rd May, 11 a.m.; visited (F.T.), 11·10; admitted to Coast Hospital, 2 p.m.; died, 23rd May, 10 p.m.; duration, 2 days. Attack, 21st May, 3·30 p.m., shivering and pain in left groin. On 20th May (Saturday) was kicked at football in the left groin, and ceased play for five minutes; 21st, no pain in groin on waking, but in afternoon the pain suddenly returned, accompanied by a violent shivering fit; he vomited; was delirious at night; became unconscious, and remembered nothing till he found himself at Sydney Hospital 23rd morning, when he recovered his senses. On examination, swelling of glands of left femoral chain, considerable periadenitic effusion, but slightly painful, extremely tender; lesions of drainage area, small recent abrasion on shin received 20th, no other; films and cultures, positive.

Rats.—At residence, no signs; at employment, evident signs of infestation; on turning over the stock, carcases of 7 rats and 18 mice were found either dried up or advanced in putrefaction. A plague-rat had been got at No. 271 (next door but two) on 4th May.

Connected Cases.—None.

CASE R.

R.D.A., f., æt. 8½. Residence, 16, Burton-street, Camperdown; attended school (St. John's) last, 22nd June; not inoculated; no former attack; no communication with any other case. Reported after death by Dr. Buchanan, Pathologist, Prince Alfred Hospital, 10th July. Cultures then submitted by him made from heart's blood were found to be positive; subcultures from them yielded no growth; guinea-pig inoculated with them died of plague. He also referred cultures from heart's blood and spleen of a guinea-pig stated to have been inoculated by him with a broth culture made from patient's spleen, which were found to be positive; subcultures made from them were positive, and guinea-pig inoculated with the spleen culture died of plague. Attack: was quite well 26th June; 27th woke with headache, vomited after drinking; at 6 p.m. delirium was observed, and soon after became stuporous; had two convulsive attacks in the course of the evening; at 9 p.m. was admitted to Prince Alfred Hospital, T. 105; died 11·15 p.m. During the morning her mother said she noticed a lump behind her left ear, and supposed mumps was beginning.

Post-mortem examination by Dr. Buchanan. *P.-m.* made 28th June, twelve hours after death. "Rigidity and lividity, well marked. *Abdomen:* No free fluid; no evidence of peritonitis. No petechial haemorrhages under visceral peritoneum. *Spleen:* Slightly enlarged (7 oz.) and very slightly softer than normal. *Kidneys:* Congested; otherwise healthy. *Liver:* Normal. *Alimentary canal:* There were several patches of congestion in the wall of the stomach. The Peyer's patches in the lower 2 feet of the ileum were enlarged, slightly congested, very granular looking on the surface, as if evidencing early ulceration. There was only very slight congestion around these patches. The solitary follicles of the large intestine, especially of the sigmoid, were greatly enlarged, and stood out as shot-like elevations. The mesenteric glands in the lower part of the mesentery were also enlarged. *Lungs:* Congested at bases. *Heart:* No petechial hæmorrhages in pericardium. No sign of peri- or endo- carditis. *Brain:* The superficial cortical vessels were much engorged, and the brain tissue was markedly hyperæmic. No gross lesion was to be found in the brain. Tissue specimens were preserved from the bowel, and cultures on blood serum and agar taken from the spleen and heart." The swelling behind the ear referred to by the child's mother either did not exist, or was overlooked. "True plague bacilli" were seen in films made from heart's blood and from the spleen at the date of *post-mortem* examination.

Rats.—It is to be regretted that Dr. Buchanan's failure to appreciate the public importance of early notification made it impossible to begin the epidemiological enquiry (and cleansing operations) until twelve days after death. Such a delay is unprecedented in our experience, but fortunately it did not actually involve serious consequences. At dwelling, no traces; parents denied presence of rats, dead or alive. In neighbourhood, which was well searched, no plague-rats, nothing suspicious. Till just before date of attack, patient's father had kept a horse, and had got feed from Maguire's produce store, about half a mile away, where in 1902 many plague-rats had been taken, and one case occurred (Report 1902, pars. 138–9); nothing could be found there. The child's mother and an elder sister said she had not to their knowledge been away from the neighbourhood of the house since ceasing to attend her school (22nd June); but a playmate said she visited a fruit shop with her, 24th June; this place was very thoroughly searched without any result. In short, the source of infection remained undetected after all enquiry had been made. Plague-rats continued to be found until 3rd December in the city, but at six places (about 2 miles away) only, of which five were wharves on Darling Harbour, the sixth a shop at some little distance from them. Nor had any been found at all near to patient's residence prior to the date of attack since 1902, or three years before.

Connected Cases.—None. The household consisted of the parents and eight children.

Case S.

W.C., m., æt. 47, married, rat-catcher of the City Council's staff. Not inoculated; no former attack; no communication with any other case. Residence, 33, Ivy-street, Darlington; employment, various places, infected and other; last employed, 12th July. Notified by Dr. R. Bohrsmann, 14th July, 11·30 a.m.; visited (R.J.M.), 12·15; admitted to Coast Hospital, 5 p.m.; died, 12th August; duration, 31 days. Attack: 12th July, had gone to bed in his usual health; on rising felt very cold, and vomited before breakfast; delivered his rats at the laboratory; went home to bed, where he remained; 13th, vomited occasionally during the day; 14th, a lump appeared in the left groin. On examination presented a bubo in the left femoral region; no lesion of drainage area seen (skin very dirty); films and cultures, positive.

Rats.—At residence, no signs. This man, as a member of the rat-staff belonging to the L.A. for the city, had been employed on buildings in the neighbourhood of the wharves, but not on the wharves; he had delivered rats regularly, but no identified plague-rat had been brought in by anyone for 14 days before his attack, nor afterwards from any place at which he had recently trapped rats.

Connected Cases.—None.

12. In 16 of these cases buboes were exhibited; Cases D (d)* and R (d) had none. The buboes were femoral and solitary in the 11 Cases A, B, C, E, F (d), H, K, L, P, Q (d), and S (d). Solitary inguinal buboes occurred in Cases N and O. In Case I a bubo in a femoral gland was attended with later, and hardly painful, swelling of an inguinal gland. The bubo was axillary and solitary in Case M; and several glands were slightly enlarged and rather tender in the posterior triangle of the neck in Case G.

13. Pain in the gland, which became the seat of bubo, was the first sign of illness in Cases A and E; and it was among the first signs in the 5 Cases F (d), I, K, L, Q (d), in which it occurred simultaneously with the initial rigor, &c. Pain, prior to swelling, or the swelling itself, was first observed at hours after attack in

---

* (d)—Died.

the 7 Cases N, M, H, S (d), C, O, and P as follows :—4 hours, 6 hours, 1 day, 2 days, 3 days, 3 days, and 5 days (doubtful). In Cases B and G the time could not be fixed, while D (d) and R (d) had no bubo.

14. Lesions within the drainage area of the gland which was the seat of bubo were sought for. The 3 Cases D (d), G, and R (d) were not notified as plague, and were either not examined or not within the requisite time. In the 9 Cases B, C, H, K, M, N, O, P, S (d) there was no lesion. In the 6 Cases A, E, F (d), I, L, Q (d) some lesion was detected, as shown below :—

Case.	Bubo.	Lesion.
A	Femoral	Small scabs and flea-bites.
E	,,	A small suppurating sore ; lymphangitis.
F (d)	,,	Hyperæmic spot on patella.
I	Femoral and Inguinal	Small recent cicatrix on sole of foot.
L	,,	Small, round, hyperæmic patch.
Q (d)	,,	Abrasion of shin, received the day before attack.

15. The associated cases were 4 pairs—namely, B and E, C and G, I and K, and M and N. *Cases B and E :* B was friendly with E, who was a staff rat-catcher, and was said to have sometimes accompanied E when he was about his work ; this was not very clearly made out, but if he did so he certainly ran into danger. B was attacked 2nd of April ; 24 hours later E took him to hospital. The first sign of E's attack occurred at some time on 6th April ; he had collected plague-rats within the usual incubation period. *Cases C and G :* Mother and son, who were living in the same house when C was attacked, 3rd April ; a plague-mouse was found in the house after notification of her case, and several dead rats were found at a stable next door. The date of G's attack cannot be fixed, but it may have been, and probably was, about the same time as E's ; his case was mild, and, after his mother had gone to hospital he removed to another house near by, to which no particular suspicion attached. *Cases I and K :* Two brothers, who kept a produce store in a suburb, where they lived together ; there was nothing to suggest infection of the house, but produce was carried there from the wharves. I's business was to visit certain Darling Harbour wharves to fetch supplies of produce ; when he fell ill K took up this part of the business, to which he had not usually attended. I was attacked 17th April, and was removed to hospital 21st April ; K was attacked 21st April. Both cases were bubonic and mild. The wharves visited were dangerous places at the time, and K would seem to have become infected only after having taken up I's business of carting from the wharves. *Cases M and N :* These men associated only at their place of employment, and, clearly enough, were infected on board the ship they were both engaged to repaint.

16. The Local Authority for the suburban borough of Woollahra detected dead rats at a tumble-down stone and wood cottage, No. 4 Morell-street ; 14 carcases were removed from it, of which 8 were ascertained in the laboratories to be plague-infected. Burrows ran to the premises next door, which were occupied by a cow-keeper ; his feed-store, which was a wood and iron structure, had an earthen floor in part covered with tarred metal, and contained a good deal of feed in bags and bales. On moving this it was found that the floor was undermined by rat-burrows in every direction, and that a disused drain opened through it. Here 32 carcases were collected, 21 of which were plague-infected. Single plague rats were afterwards collected from each of 2 premises in John-street and Peaker-lane, at a considerable distance from Morell-street. The Local Authority detected the mortality in the course of watch it was keeping on the rats within its district ; as soon as plague was identified, the Department assumed supervision, and carried out the necessary cleansing work with assistance of labour supplied by the Local Authority under direction of its Sanitary Inspector (Mr. Wormall, Cert. R. San. Inst.). Produce had been received at the dairy shortly before from infected wharves at Darling Harbour. It will be observed, first that the infection was conveyed to this distant suburb *per saltum* in connection with the transport of produce (as usual) ; and secondly, that the Local Authority had not enforced the By-laws made by it for Better Prevention of the Spread of Plague by Rats (*see* Report 1903, Appendix A), in that the feed-store at the dairy had not a floor of

concrete or of other approved material impervious to rats. The attention of the Local Authority was drawn to the probability that had it had such a floor there could have been no such rat-warren as existed, and although the disease might have been imported, it would have had very small opportunity of spreading. Fortunately the outbreak was soon brought under control, and the only result as regards man was infection of Case O, the backyard of whose house was separated from the cow-keeper's only by a dilapidated fence.

17. Plague was identified in rats or mice taken at 28 premises, which may be classified as follows :—Darling Harbour wharves (and 1 bond, 1 coasting steamer alongside), 15 ; produce stores (1 cow-keeper), 6 ; private houses, 4 (1 close to infected wharves and next to an infected stable, 3 at Woollahra) ; 1 hotel, 1 general importer, 1 tailor.

18. The methods of prevention continued the same as have been previously described.

19. The forms hitherto in use by Staff Medical Officers, by the Medical Staff at the Coast Hospital, and by Staff Sanitary Inspectors, are now printed in Appendix A.

J. ASHBURTON THOMPSON.

This Diagram shows the places at which plague-rats were taken, during 1905, by red spots consecutively numbered in accordance with the date on which the first was taken at each place. It also shows, by capital letters, the places at which eighteen persons who had plague were employed, and, by lower-case letters surrounded with a circle, the places at which they resided. Cases in which the place of employment and of residence were one are distinguished by capital letters enclosed in a square. The boundaries of the wards into which the City proper is divided are shown by broken red lines.

The following table shows the places at which, and the first and last dates on which, plague-rats were taken; the entries are consecutively numbered in accordance with the dates on which they were first taken.

References to the eighteen cases are inserted in the series in their order, according to date of attack, and these are not numbered.

No.	Place.	Infected rodents taken.				First	Last.
		Total.	M. Dec.	M. Rat.	M. Mus.		
1	North Coast Wharf, Nos. 1 and 2	16	13	3	...	18-1-5	13-9-5
2	A.U.S.N. Wharf, Nos. 1 and 3	16	14	1	1	1-2-5	15-4-5
3	S.S. "Tomki," North Coast Wharf, No. 1	2	2	...	...	14-2-5	14-2-5
4	Union Wharf, Margaret-street, Nos. 1 and 2	3	2	1	...	20-2-5	5-4-5
5	Union Wharf, Druitt-street, Nos. 1 and 2	6	5	...	1	27-2-5	20-3-5
6	Nicoll's Wharf	3	2	1	...	9-3-5	13-4-5
7	123-127, Sussex-street	7	1	3	3	10 3 5	22 3-5
	Case A.—Attacked, 11-3-5.						
8	Lockley's Wharf	2	1	1	...	15-3-5	23-3-5
9	9, Wharf-street	1	...	1	..	21-3-5	21-3-5
10	Pyrmont Bridge Wharf	2	1	1	...	22-3-5	14-7-5
	Case D.—Attacked, 24-3-5.						
11	Federal Wharf, No. 2 and Bond	25	1	18	6	27-3-5	5-12-5
	Case B.—Attacked, 2-4-5.						
	Case C.—Attacked, 3-4-5.						
12	304, Kent-street	10	...	8	2	5-4 5	14-4-5
13	In Sussex-street, near Public School	1	1	...	...	5-4 5	5-4-5
	Case E.—Attacked, 6-4-5.						
14	40, Bathurst-street	1	...	...	1	7-4-5	7-4-5
	Case G.—Attacked, 8-4-5.						
	Case F.—Attacked, 9-4-5.						
15	137, Sussex-street	5	..	4	1	12-4-5	20-4-5
	Case H.—Attacked, 16-4-5.						
	Case I.—Attacked, 17-4-5.						
16	D. Murphy's, 4, Morrell-street, Woollahra	8	8	...	...	18 4 5	19 4 5
17	T. Lynch's, 2, Morrell-street, Woollahra	21	21	...	...	20 4 5	22 4 5
	Case K.—Attacked, 21-4-5.						
18	40, John-street, Woollahra	1	1	...	...	22-4-5	22 4-5
	Case L.—Attacked, 23-4-5.						
	Case M.—Attacked, 24-4-5.						
19	"Cochrane's Hotel," 10, Wharf-street	1	1	...	...	29-4 5	29-4-5
	Case O.—Attacked, 2-5-5.						
20	No. 1, Corporation Stores, 173, Sussex-street	1	...	...	1	2-5-5	2-5-5
21	4, Peaker-lane, Woollahra	1	1	...	...	2-5-5	2-5-5
	Case N.—Attacked, 4-5-5.						
22	271, Sussex-street	1	...	1	...	4-5-5	4-5-5
	Case P.—Attacked, 13-5-5.						
	Case Q.—Attacked, 21-5-5.						
	Case R.—Attacked, 27-6-5.						
23	Market Whar	1	1	...	...	28-6-5	28-6-5
	Case S.—Attacked, 12-7-5.						
24	Saywell's Wharf	1	...	...	1	14-7-5	14-7-5
25	Lumber Yard, Lime-street	1	...	...	1	17-7-5	17-7-5
26	Dingle's Bond, off King-street	1	1	...	...	4-8-5	4-8-5
27	107, King-street	1	1	...	...	15-8-5	15-8-5
28	Harbour Trust's Wharf	2	...	2	...	20-11-5	22-11-5
	Total	141	78	45	18	......	......

PREPARED FOR THE DEPARTMENT OF PUBLIC HEALTH.

MAP OF THE

CITY OF SYDNEY

AND

ADJACENT MUNICIPALITIES.

SCALE

THIS DIAGRAM SHOWS THE PLACES AT WHICH PLAGUE-RATS WERE TAKEN DURING 1905, THE PLACES AT WHICH PERSONS WHO HAD PLAGUE WERE EMPLOYED, AND THE PLACES AT WHICH THEY RESIDED.

EXPLANATORY NOTES.

Places at which plague-rats were taken, consecutively numbered in accordance with the date on which the first was taken at each place.— —shown thus — — 22-●

Places at which persons who had plague were employed — — — do — — — — — A

Places at which persons who had plague resided — — — — — do — — — — — ⓐ

Places at which persoons who had plague both resided and were employed — — — — — — — — — do — — — — — B

Boundaries of the Wards into which the City proper is divided — do — — — — — —

NOTE.—The places at which patients D, E, F, G, and S were employed cannot be shown, either they were not identifiable, or else were in streets, &c. (See detail notes).

J. Ashburton Thompson.

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19 JUN. 1923
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REPORT

ON

Outbreaks of Epizoötic and of Epidemic Plague on the Northern Rivers, 1905.

By R. J. MILLARD, M.B., Ch.M. (Syd.), D.P.H. (Camb.),
Assistant Medical Officer of the Government and Assistant Microbiologist to the Board of Health.

The Assistant Medical Officer of the Government to the President of the Board of Health.

Department of Public Health,
27th November, 1905.

THE OUTBREAK AT ULMARRA, ON THE CLARENCE RIVER.

Part I.

General Description of Ulmarra.

Ulmarra is situated on the right bank of the Clarence River (Lat. 29·42 S.), its business centre, which contains stores, two hotels, post-office, &c., being just 9 miles by road or river below Grafton. The district was incorporated in 1871 as a municipality, having an area of 28,000 acres; and this large area, with the exception of the business centre above-mentioned, is entirely rural in character, being occupied by farms chiefly devoted to dairying and the production of maize and sugar-cane. Most farmers combine all three.

Population, Dwellings, &c.—At the census of 1901 population was 1,722. The dwellings were 288, of which it is noted that 277 were of wood, and 77 per cent. contained five or more rooms. These figures are probably approximately correct at the present day.

Soil, Topography, &c.—The municipality has a frontage of about 12 miles to the Clarence River, which forms its western boundary. On the east it is bounded in part by the Coldstream River, a small tributary of the Clarence, and the area thus demarcated is roughly triangular having a southern base of about 7 miles and a northern apex at the junction of the Coldstream with the Clarence. The contour of the country is generally flat, and in consequence of this almost the whole of the municipality is liable to be flooded on the rare occasions when the Clarence overflows its banks. The soil throughout the district is alluvial, of exceptional depth and richness.

Products, Communications, &c.—As already stated, the community is engaged solely in farming pursuits. It exports large quantities of butter, eggs, maize, and other farm produce, and receives general merchandise, as well as empty corn-sacks, egg-boxes, &c. Trade is carried on by steamers. Local steamers ply up and down the river between Grafton and all wharves for more than 30 miles below Grafton. There are altogether some six or seven small steamers thus engaged carrying passengers and goods, and supplying a morning and afternoon service every day. Besides this local trade there is regular communication by ocean steamers with Sydney and Brisbane. The Sydney trade is carried on by the North Coast Steam Navigation Company with a fleet of four steamers, the "Kyogle," "Kallatina," "Nymboida," and "St. George." The two former run regularly between Grafton and Sydney, maintaining a semi-weekly service, and call at all the more important wharves on the river, including Ulmarra. They carry passengers as well as cargo. The two latter carry cargo only, and run less regularly as required by the exigencies of trade. Grafton, the terminal point of the voyage from Sydney, is reachep generally in the afternoon, and the steamer lies there alongside the wharf for two nights and a day before commencing the return voyage. At Ulmarra, as at other wharves, the steamers stop only long enough to discharge or embark passengers and cargo. Between Clarence Heads and Sydney these steamers have no port of call.

The Brisbane trade is very much smaller, and is carried on by one small steamer, the "Pyrmont," which makes weekly trips from Brisbane to the Clarence, calling at Ballina, on the Richmond, both going and coming.

House Accommodation.—The dwellings, generally speaking, are of a good class and comfortably furnished. They are, however, almost universally of wood (96 per cent. at the last census), and mostly have been built a good many years. Both these circumstances are of importance in relation to infestation by rats. Cesspits are common, except on registered dairy premises, on most of which there is a pail-closet of some description, often very primitive. The cesspits are mere holes in the ground, with walls sometimes slabbed, sometimes not, but never water-tight. These pits are almost invariably a happy hunting-ground for rats, and the walls are riddled with rat runs.

The farm buildings, barn, pigsties, cow-bails, are very rarely of a solid up-to-date character, and in many cases are flimsy and makeshift. The ordinary type of barn has a large door at each end, and a roadway by which a cart may be driven through. On either side this roadway inside the barn, are the "straddles" on which the crop of maize, hay, &c., is stacked. In the better-class barns these straddles are platforms raised well off the ground, but in many they are merely planks or fence rails laid on logs which rest on the earth. Such barns offer exceptional attractions to rats, providing abundant food, and a sheltered, seldom disturbed region in which they may burrow and make their nests. In many cases these straddles are not disturbed from year to year, the new crop being carted in on top of the remains of the old. Even when the crop of maize has been bagged and sent away, there remain the husks and the cobs which lie about in heaps and are kept for winter fodder and for fuel respectively. Thus, for one reason or another, many barns never get a thorough turning out.

The pigsties are of the simplest description, the pens are generally floored roughly with fencing rails, and there is often some similar flooring round the feeding troughs. Here again is shelter of which the rats avail themselves.

Sanitary administration in the municipality is practically a dead letter. There is an Inspector of Nuisances, so-called, but he receives only a nominal salary, and, like many of the aldermen, is himself a dairyman. Consequently individual householders are in the main left to follow their own ideas of what is sanitary, undisturbed by any enforcement of the provisions of the Public Health or other Acts. With regard to dairy premises some action has in times past been forced upon the Council by the Board in consequence of reports of the Board's Veterinary Inspectors, but the general condition of these premises shows that there has been no continuous supervision by the local authority or attempt to require provision of suitable structures and observance of cleanly methods. Untidiness of premises and uncleanliness of bails and yards are the prevailing characteristics, and in the methods adopted in the actual milking there is very little regard for cleanliness.

PART II.

PLAGUE IN MAN.

The first intimation to this Department of Plague in the Clarence River District was conveyed in a telegram from Dr. Page, of South Grafton, received on 4th January, 1905, in which he reported his strong suspicions as to nature of illness of P.C. (Case D), then a patient in his private hospital at South Grafton.

In accordance with your instructions, I at once proceeded overland to Grafton, taking with me an experienced sanitary inspector, a laboratory assistant, and a rat-catcher, together with an equipment of microscope and other necessaries for bacteriological examination, a spray pump and disinfectant, and a supply of rat-traps.

On my arrival at Grafton on 7th January, 1905, I was able from examination of the patient P.C. and of microscopical preparations from his bubo to confirm Dr. Page's diagnosis of bubonic plague. Also, I obtained particulars of 5 other cases of suspicious illness which had occurred in the Ulmarra district in the past three weeks. Four of these had had a rapidly fatal termination, whilst the other case had reached the stage of convalescence. The information supplied by the medical attendants, and by the friends and relatives, showed fairly conclusively that these four deaths had been due to plague. Examination of the convalescent case showed that he had still a femoral bubo, from which I obtained material which contained the *Bacillus pestis*. This was demonstrated in the Board's laboratory morphologically, culturally, and by inoculation.

The first of these cases was attacked on 14th December, 1904. Careful search of the death register and inquiry of the local medical practitioners failed to discover any prior case which was in any way open to suspicion of having been of the same nature. In a rural district like Ulmarra it is comparatively easy to learn the comings and goings of any strangers, and the movements of the members of any given household. There was, however, nothing to suggest that E.W. (Case A) had been in any way associated with any infected person.

I remained in the district until 11th March, during which period there were 6 other cases. Two months after my departure 1 other case occurred, after which there were no more for the rest of the year.

The epidemic thus extended over the period, 14th December, 1904, to 6th May, 1905, the attack dates of the 13 cases being as follows:—

14th December	Case A.
29th ,, ...	,, B and C.
30th ,, ...	,, D and E.
1st January	,, F.
21st ,, ...	,, G.
22nd ,, ...	,, H.
23rd ,, ...	,, J.
26th ,, ...	,, K and L.
27th ,, ...	,, M.
6th May	,, N.

Thus there was an interval between Cases A and B of 15 days, between F and G of 20 days, and between M and N of 99 days.

Several other cases were reported to me as possibly cases of plague, but in all I was able to negative this diagnosis, and I have no reason to suppose that any cases of plague occurred which were not reported.

In the beginning of May (the date of attack of Case N), during my absence from the district, two Hindoo farm labourers, Booda, aged about 50 years, and his nephew, Dola, aged 25 years, died on 4th May and 10th May respectively, after only a few days' illness. The latter of these two cases was admitted to the Grafton Hospital and was reported as possibly a case of plague, but after full inquiry into the circumstances it seemed more probable that both Hindoos had died of ordinary pneumonia.

The circumstances connected with the 13 cases of plague were as follows:—

Case A.—Wilcox, Elizabeth M.

Summary.—Female, æt. 24 years; single; domestic duties. No former attack; never inoculated; no communication with any previous case. Resided with her grandparents, Kelly by name, in a farmhouse on the right river bank, about 4 miles below the township of Ulmarra. Attacked 14th December, died early on 17th December. Right inguinal bubo. No bacteriological examination.

Movements prior to attack.—Had not been away from the district for a very long time, but was a frequent visitor at Clarke's farm (*vide* Case D), and on Sunday afternoon, 11th December, *i.e.*, about 60 hours before she was attacked, had sat in Clarke's barn, where sick and dead rats were already at that date being observed, and whence, on 9th and 10th January, there were obtained 50 rats and 65 mice in a mummified condition.

History of Illness.—The following account was obtained from her relatives and her medical attendant:—Was in her usual good health when she went to bed on 13th December. 14th December: Felt ill on waking; bad headache; seen by doctor about 3 p.m.; then had temperature 105°, severe headache, bloodshot eyes, and abdominal pain. 15th December: Seen by medical attendant 11 a.m.; temperature 103·2°; felt better, but abdominal pain was severe, and she now had pain and acute tenderness in right groin; peritonitis was suspected, but bowels were freely open and abdomen not distended. 16th December: Seen by medical attendant at 11 a.m.; temperature 102°; said she felt better and that she had no pain, but the abdomen was found to be still tender; during the next night she complained of feeling cold, and she died quite suddenly in the early morning of 17th December. Cause of death was certified by her medical attendant as "Peritonitis, Syncope."

Residence.—A comfortable, cleanly kept farmhouse, near the river bank.

Rats.—At her residence, no history of dead or sick rats was obtainable, nor were any indications of such found when the premises were carefully searched on 9th and 10th January. The finding of sick and dead rats at Clarke's barn, where she had sat 60 hours before her attack, has already been mentioned.

Further cases.—There were no further cases at her place of residence.

CASE B.—PLUMMER, VINCENT.

Summary.—Male, æt. 17 years; single; farm-worker. No former attack; never inoculated; no communication with any previous case. Resided with his parents on the bank of the river, and about half a mile below the residence of Case A, and about 4½ miles below Ulmarra township. Attack, 29th December; convalescent on 3rd January. Left femoral bubo. Morphological, cultural, and inoculation tests positive.

Movements prior to Attack.—Had not been away from the district for many weeks; had been to Ulmarra township frequently.

History of Illness.—Supplied by his relatives, his medical attendant, and himself:—29th December: He was taken suddenly ill about 10 a.m.; "went in the legs," and was thought to have sunstroke; on the same morning he noticed a left femoral bubo. 31st December—Temperature—morning, 104·2° F.; evening, 103°; delirious at night. 2nd January—Seen at noon by medical attendant; had temperature 104°, seemed very ill, and was muddled and stupid, unable to answer questions. 3rd January—Temperature normal; on this day he got up to attend his father's funeral, and he did not go back to bed. Seen by me on 8th and 9th January; pulse and temperature normal; says he feels perfectly well; looks somewhat languid; bubo, left femoral, still present, rather larger than an unshelled almond, and slightly tender on manipulation; no skin lesion on the drainage area of the femoral group of glands. On 9th January I punctured the bubo with a sterile hypodermic syringe, and withdrew a small quantity of material. Smears of this showed no bacilli, but an agar culture made at the same time gave a growth which was subsequently proved both morphologically and by inoculation to be *Bacillus pestis*. His subsequent history was uneventful; he resumed ordinary work, and the bubo gradually resolved.

Residence.—A farmhouse of fairly good construction, but badly infested with fleas. The barn is about 15 yards from the house. After the death of the parents the family abandoned this residence and built another.

Rats.—When search was made by the staff, on 8th January, 3 rats and 1 mouse were found dead and mummified in the barn. No live rats were seen or caught. No history could be obtained of any dead or sick rats about the place; but the complete absence of live rats at the time of the examination of the premises suggested that they had been driven away by some unusual cause, since the barn offered abundant food and shelter. Subsequently, infected rats were obtained at points on the river bank both above and below these premises.

Contacts and Further Cases.—At the residence the household comprised, besides the patient, his father and mother, two sisters, and a brother. The father and mother both became infected (Cases E and F), as did also a frequent visitor to the house (Case C).

CASE C.—CAMPBELL, EDWIN BRIGGS.

Summary.—Male, æt. 34 years, single, farmer; no former attack; never inoculated; no communication with any previous case. Resided some 6 miles from Ulmarra township, near the Coldstream River. Attacked on 29th December, died on 1st January. No bubo was observed; bacteriological tests were not made.

Movements prior to Attack.—He had not recently been away from the district; went frequently to Ulmarra, and was a frequent visitor at the home of Cases B, E, and F. He spent Christmas Day there, and was there again on 28th December.

History of Illness.—The following account was obtained from his medical attendant and from his relatives:—29th December—He was taken suddenly ill during the evening with aching of limbs and of body generally; was thought to be suffering from sunstroke. 30th December—Seen by his medical attendant for the first time soon after midnight; headache, intense; temperature, 105° F; heart apex displaced outwards, mitral murmur; no tenderness anywhere. 31st December—Morning temperature, 101° F; felt generally better, but had had a sleepless night, with much vomiting. 1st January—Seen by his medical attendant about 10 a.m.; he had had no sleep; temperature was 103·5 F; vomiting had ceased, but he was suffering from diarrhœa; about 10·30 a.m. he had a drink, felt inclined to vomit, sat up to do so, and at once died. The body became rapidly discoloured after death, so as to be soon unrecognisable. The cause of death was certified by his medical attendant as "Syncope, due to chronic cardiac disease," but the case was probably one of Septicæmic Plague.

Residence.—The residence was a perfectly new, good-class, wooden cottage, in which he had been living only a few weeks. It was situated about 6 miles from Ulmarra, and 3 or 4 miles from the nearest place at which infected human beings or rodents were found.

Rats.—No rats were found at the residence. As above stated, this patient was a frequent visitor at the home of Cases B, E, and F. Mention had already been made of the rats in connection with these premises.

Contacts and Further Cases.—At his residence, 1 contact. No further cases occurred here.

Case D.—Clarke, Percy.

Summary.—Male, æt. 25 years; single; farm-worker; no former attack; never inoculated; no communication for at least 13 days with any previous case. He had been associated with Case A; but she died on 17th December. Resided on his father's farm premises, about 1½ mile below Ulmarra township, on the right bank of the river. Attacked 30th December, about 10 p.m.; strangulated femoral hernia diagnosed. Removed to private hospital in South Grafton on 1st January; reported by medical attendant as plague on 4th January. Seen by me on 7th January; remained in hospital till 17th February; right femoral bubo; smear showed abundant *B. pestis.*

Movements prior to Attack.—Had not been away from Ulmarra; had been occupied about the farm.

History of Illness.—30th December, about 10 p.m., was taken suddenly ill with rigor, intense headache, aching in limbs and back, vomiting, and acute pain in right groin. 31st December—Prostrated and semi-delirious; bubo about size of walnut; bowels constipated; much vomiting; strangulated femoral hernia diagnosed by his medical attendant, and removal to private hospital, South Grafton, arranged. 1st January—Admitted to hospital in early morning and at once operated on; incision disclosed no hernia, but acutely inflamed hemorrhagic femoral gland, which was removed. Smears made from this gland showed abundant *B. pestis.* Temperature, which on admission was 105°, fell that evening to 99·2° at 6 p.m.; but he remained in a condition of muttering delirium, which continued for 4 days, and the temperature rose again next day to 101·6° at 2 a.m.; and for the next 5 days reached 102° at some period of each day, this alternating with drops to normal; the pulse throughout remained about 110 and soft. 7th January—I saw the patient for the first time; the wound had been stitched, but showed no tendency to heal, and on this day the stitches were removed and antiseptic foments applied to promote the separation of the sloughs which had formed; the subsequent course of the case was tedious and prolonged, owing to the suppuration of some deep-seated inguinal glands. Patient left hospital on 17th February, 1905, with sinus still discharging.

Residence.—The actual residence, a large comfortable wooden cottage, was on one side of the main road, and on the other side, between the road and the river bank, was the barn, as well as other farm buildings. This barn was of the inferior type described above, the "straddles" being merely logs and fence rails laid on the ground.

Rats.—About the barn numerous dead and sick rats were found early in December, and when the place was thoroughly turned out by the staff, on 9th and 10th January, 50 rats and 65 mice were found, but all in a mummified condition, which precluded any bacteriological examination as to the cause of death. Poison had not been laid here, and it was evident that the mortality had been due to an epizootic.

Contacts.—A large family—parents, brothers, and sisters—lived at the same residence with the patient. No further cases occurred here.

Case E.—Plummer, Henry.

Summary.—Male, æt. 65 years; married; farmer; no former attack; never inoculated. Lived in same residence with Case B. Attack on 30th December, about 3 a.m. (17 hours subsequent to the attack of Case B); died 2nd January, about 4 p.m. No bubo observed; no bacteriological examination.

Movements prior to Attack.—Had not been away from district; had been to Ulmarra occasionally on business.

History of Illness.—Supplied by his relatives and his medical attendant. Patient had an inguinal hernia, and was subject to occasional attacks of vomiting, believed to be connected with this; he was, however, in his usual health up to 30th December. 30th December—Shivering and vomiting came on about 3 a.m., and, later, vertigo and diarrhœa; during the afternoon his temperature was 104°. 2nd January—On this day, about noon, he was seen for the first time by his medical attendant, who found temperature and pulse normal, hernia down, but reducible without pain; patient complained of nothing but the intense heat of the weather (it was 117° F. in the shade that day); about 4 p.m. he collapsed and died suddenly; the cause of death was certified as "Heat exhaustion and syncope," but, on consideration of the history and circumstances, I am of opinion that this was a case of Septicæmic Plague.

Residence, Rats, Contacts.—*Vide* under Case B.

Case F.—Plummer, Mary Ann.

Summary.—Female, æt. 60 years, wife of Case E; no former attack; never inoculated. Lived with Cases B and E. Attack on 1st January, about 8 p.m. (*i.e.*, about 90 hours subsequent to Case B; died 4th January, about 3 a.m.; duration of illness, 55 hours; left femoral bubo; no bacteriological examination.

Movements prior to Attack.—She had not been away from home for many weeks, except to go occasionally to Ulmarra.

History of Illness (as supplied by relatives and medical attendant).—She had been in her usual health, attending to her husband and son (Cases B and E) up to the evening of 1st January. About 8 p.m. had a rigor, then headache, vomiting, and general aching; was delirious during the night, with temperature 103° F. 2nd January—Seen about noon by medical attendant; then had severe headache, temperature 105°, and tongue furred and dry; delirious again during the night, with more vomiting. 3rd January—Seen by medical attendant shortly before midnight; was then dying; temperature, 104·3°; she had complained of pain in left thigh, and there was now a definite tender induration in the left Scarpa's triangle. 4th January—Died about 3 a.m.; cause of death certified as "Heat exhaustion—syncope."

Residence, Rats, Contacts.—*Vide* under Case B.

Case G.—Donaldson, James.

Summary.—Male, æt., 25 years, married, store employee; no former attack; never innoculated; no communication with any previous case. Residence, Grafton Road, Ulmarra, about 200 yards from place of employment, Retallick's general store. Attacked, 21st January. Notified by his medical attendant at 10 a.m. on 22nd; seen by me at 11·30 a.m., and admitted to Grafton Hospital 6 p.m. on the same day; discharged from hospital, 24th February; duration of illness, 34 days. Left femoral bubo; morphological and cultural tests positive.

Movements before Attack.—Had not been away from Ulmarra for many weeks, except for an occasional visit to Grafton.

History of Illness.—20th January—After working at pulling weeds all the morning, noticed about 1 p.m. that back was painful. Had no shivering or other symptom, and paid little attention to the pain. Had an uneasy night on account of pain in back. 21st January—Went to work as usual at 6·30 a.m. During the day pain in back became worse, and in the afternoon he noticed tender spot in left groin. About 4 p.m. went home, unable to work any longer. Seen and treated on same evening by his medical attendant, who reported the case next morning. 22nd January—Seen by me at 11·30 a.m. In bed. Flushed, with suffused eyes. Complains of headache, giddiness, and painful lump in left groin; temperature, 103·4°; pulse, 112, with tendency to dicrotism. Bubo is a left femoral gland about the size of a marble, slightly prominent above the surface. No cuts or wounds on leg or foot. Two fading papules—possibly flea bites—on inner surface of left thigh. Fluid from bubo, withdrawn with hypodermic syringe, did not show any bacilli, but the diagnosis being clinically definite, I injected at 1 p.m. 60 c.c. Yersin serum (L.I.P.M.) into right chest wall, and made arrangements for his removal at once to Grafton Hospital. This was accomplished during the afternoon, and he was admitted at 6 p.m.

At 1 p.m. (injection of serum), temperature 104; at 2·30 p.m. (on leaving home) temperature 105·4°; pulse, 116. At 6 p.m. (on admission to hospital), temperature, 104·6°; pulse, 124. At 9 p.m. another injection (40 c.c.) of serum was given. During the night he vomited, was slightly delirious, and had retention of urine. At midnight, temperature, 105·6°; pulse, 120. 23rd January—Temperature, 8 a.m., 104·8°; 8 p.m., 102·8°; pulse, 8 a.m., 116; 8 p.m., 96. Vomited again 10·30 a.m. At 11·20 a.m. further injection of serum (40 c.c.). Is also having a mixture containing quinine and digitalis. Further specimen obtained this day by puncture of bubo showed *B. pestis* in smear and in culture. At night very restless; no sleep after 1 a.m. Vomited frequently. 24th January—Temperature, 8 a.m., 102·4°; 8 p.m., 103·6°; pulse, 8 a.m., 94; 8 p.m., 96. Suffered a great deal with backache and a troublesome cough. Towards evening and at night was delirious, and slept only after trional gr. 30. Bubo painful. 25th January—Temperature, 4 a.m., 103·8°; 8 a.m., 101·8°; 8 p.m., 102·4; pulse, 8 a.m., 96; 8 p.m., 120. Delirious and restless all day; very delirious at night. Further injection of serum (40 c.c.) at 8·45 p.m. 26th January—Temperature, 8 a.m., 102°; 8 p.m., 102·4°; pulse, 8 a.m., 100; 8 p.m., 116. Very restless and delirious all day. Had slight epistaxis at 11·30 a.m.; pulse intermittent at times; respiration rapid, 48 most of afternoon; had a good night; slept soundly. 27th January—Temperature, 8 a.m., 101·2°; 8 p.m., 101·5°; pulse, 8 a.m., 104; 8 p.m., 96. General condition during day better. Bubo very painful. At night very restless, and delirious from 10·30 p.m. 28th January—Temperature, 8 a.m., 100·8°; 8 p.m., 101°; pulse, 8 a.m., 96; 8 p.m., 88. Condition much improved. Slept well all night. 29th January—Temperature, 8 a.m., normal; 8 p.m., normal; pulse, 8 a.m., 80; 8 p.m., 92. From this onward, progress was steady. 2nd February—Bubo was freely opened. 9th February—Large slough separated. 3rd March—Discharged convalescent. Wound had almost healed, and he was able to hobble about with a stick, though much pulled down by his illness.

Residence.—A comfortable cleanly-kept cottage, between Grafton Road and the river bank, about 300 yards above the public wharf.

Employment.—Retallick's general store; clean and well kept, but next door to the "Exchange Hotel" (*vide infra.*) The back yards are separated by an open fence only.

Rats.—At residence there was no evidence of rats, and none could be caught. At employment, there were found in the store stables on 23rd January, 1 putrid and 1 skeleton rat, as to which the cause of death could not be ascertained. In the stables and outhouses of the adjoining "Exchange Hotel" there had been found on 11th, 12th, and 13th January 42 plague-infected rats; and in a shop next door on the other side there were found on 23rd and 24th January 3 dead rats; but these last were too putrid for determination of the cause of death.

Contacts and Further Cases.—At residence, 3 contacts; at employment, 4. No further cases occurred at either place.

CASE H.—YOUNG, HARRIET ISABEL.

Summary.—Female, æt., 49 years. Single; domestic duties; no former attack; never inoculated; no communication with any previous case. Residence and employment at her father's house at Cowper, about 6 miles below Ulmarra township, on the right bank of the river. Attack, 22nd January. Notified by her medical attendant on 23rd January. Seen by me at 3 p.m. the same day, and again on 24th. Admitted to Grafton Hospital at 12·30 p.m. on 25th. Discharged 24th February. Duration of illness, 34 days. Bubo, left femoral. Morphological and cultural tests positive.

Movements before Attack.—Had not for months been further away from her home than to go to her next-door neighbour, or to the church close by.

History of Illness.—22nd January. Having gone to bed overnight in usual health, vomited at 6 a.m. and felt feverish. Seen by her medical attendant, who found some pyrexia. Stayed in bed. 23rd January—Seen by me at 3 p.m.; temperature, 102·2°; pulse, 112. In left groin there was definite enlargement of a femoral and an inguinal gland, which were not, however, tender. Fluid from this bubo showed no definite bacilli. 24th January—At 1 p.m., temperature 103°; pulse, 98; dropped a beat occasionally. Enlarged glands about same. Further specimen of gland juice obtained this day showed *B. pestis* in smear and culture. 25th January—Patient admitted to Grafton Hospital at 12·30 p.m. At 8 p.m. temperature 102·8°; pulse, 100; respiration, 40. Slept well at night. 26th January—Temperature, 8 a.m., 101°; 8 p.m., 100°; pulse, 8 a.m., 108; 8 p.m., 96. Drowsy all day, and slept well at night. 27th January—Temperature, 8 a.m., 99·2°; 8 p.m., 99·8°; midnight, 102°; pulse, 8 a.m., 84; 8 p.m., 84. Comfortable all day, but at night complained of severe pain in right shoulder. Bubo somewhat painful. 28th January—Temperature, 8 a.m., 99·6°; 8 p.m., 100·6°; pulse, 8 a.m., 94; 8 p.m., 92. This patient's course was uneventful. By 30th January temperature had fallen to normal, and it remained so with the exception of a rise to 101·4° at 8 p.m. on 5th Februay. The bubo was indolent, never acutely tender, and gradually diminished in size, though not subsiding entirely. 24th February—Discharged.

Residence.—A roomy but old cottage, situated on the river bank, near Cowper, about 6 miles below Ulmarra township. In some of the back rooms and in the kitchen the floor joists had partly rotted away, letting the floor boards down on the earth. The closet was an old cesspit.

Rats.—The premises were cleansed and searched on 26th and 27th January, when 16 rats and 1 mouse were found dead; 7 of these were putrid, the rest skeletons. In none could the cause of death be determined; but it was ascertained that poison had not been laid. Six putrid rats and 4 skeletons were found under the back verandah and under the floor of a back room occupied by the patient. The rest of the rats and the mouse were found in the buggy shed and barn.

Contacts and Further Cases.—Two other persons lived at the same residence; but there were no further cases.

CASE J.—PAINE, WILLIAM.

Summary.—Male, æt. 37 years; married; store employee; no former attack; never inoculated; no communication with any previous case. Residence in Ulmarra township, a few hundred yards from Glisson's store, where he was employed. Attacked 23rd January, 8 p.m.; notified by his medical attendant on 24th January, about 3 p.m.; seen by me at 3·30 p.m. same day. Admitted to Grafton Hospital on 27th January, at 4 p.m.; died, 30th January, at 9 p.m; duration of illness, 7 days. Septicæmic plague; no bubo. Morphological and cultural tests positive.

Movements before Attack.—He had not been out of the district, but his daily duty was to drive a hawker's van round from farm to farm.

History of Illness.—23rd January—Began to have "bilious" headache after midday; ate no tea; head worse in evening—felt giddy; slept fairly well. 24th January—Went to work at 6·30 a.m., though feeling giddy and weak, and retching occasionally; about 11 a.m., while out in country driving a van, he vomited and collapsed, incapable of further effort; suffered severe headache; at 3·30 p.m., temperature 105°, pulse 128; severe headache and prostration; no bubo to be found; at 8·50 p.m., more prostrated and semi-stuporous; temperature, 104·6°; pulse, 128; injected Yersin serum, 60 c.c.; took pipette of blood from finger, which showed no *B. pestis* in smear or culture. 25th January—At 2·25 p.m., much improved, bright and intelligent again, temperature 102·2°, pulse 102; still inclined to vomit after food or drink; at 4·40 p.m., temperature, 101·8°; pulse, 108; injected Yersin, 40 c.c. 26th January—Had a fairly good night till midnight, after which he vomited violently many times; at 2 p.m., clear-headed, but complaining of headache; temperature, 104·8°; pulse, 108; no bubo; injected Yersin, 60 c.c. 27th January—7 a.m., temperature, 104°; Yersin, 60 c.c., injected; admitted to Grafton Hospital, 4 p.m., temperature, 105·2°; pulse, 107; Yersin, 40 c.c., at 4·30 p.m. 28th January—Temperature, 8 a.m., 100·8°; 8 p.m. 106°; pulse, 8 a.m. 118, 8 p.m. 136; respiration, 8 a.m. 44, 8 p.m. 50; very ill; respiration rapid, but no physical signs of lung disease; no bubo. 29th January—Temperature, 8 a.m. 100°, 8 p.m. 103·4°; pulse, 8 a.m. 120, 8 p.m. 126; respiration, 8 a.m. 58, 8 p.m. 59; stuporous all day, delirious at night; severe dyspnœa at 3 p.m.—became very cyanosed; impaired resonance and some moist rales at left base; tenderness over left zygoma, immediately in front of ear-lobe. 30th January—Temperature, 8 a.m. 104°; pulse, 8 a.m. 140; respiration 70; drowsy, but not unconscious; over left zygoma a hard tender gland, about size of haricot bean; gradually became unconscious, and died about 9 p.m. 31st January—*Post-mortem* examination ten hours after death; rigor mortis slight; *post-mortem* lividity not well marked; no bubo, but parotid lymphatic gland was about size of haricot bean, and a deep inguinal gland on the right side was enlarged. Abdomen: No petechial hæmorrhages, peritoneal fluid not excessive, appendix normal; spleen large, hard, and firm, rather darker than normal; liver enlarged, firm, and pale; surface and substance riddled with small necrotic patches, $\frac{1}{8}$ to $\frac{1}{4}$ of an inch in diameter; kidneys large and pale, capsule slightly adherent, cortex not diminished, no hæmorrhages; iliac and mesenteric glands generally somewhat enlarged. Chest: Left lung base almost solid and very dark, sank in water; no pleurisy; some infarcts, size of a pea, on the surface; right lung fairly normal; heart, no gross change; skull, not opened. Microscopically, smears from liver showed very abundant bacilli, morphologically identical with *B. pestis*; smears from spleen and left lung base showed a few bacilli doubtfully similar. Cultures from liver showed *B. pestis* pure; spleen showed no growth. Lung showed pneumococcus and streptococcus pyogenes.

Residence.—A comfortable, cleanly-kept, new cottage. No stable. Pail closet.

Employment.—General store, fairly well kept, but with the usual amount of ramshackle outbuildings, cases, and rubbish.

Rats.—None obtained at either residence or employment. At the Police stables, and at McMahon's timber yard, two doors from the store where patient was employed, 9 infected rats were found on 28th January.

Contacts and further Cases.—At the residence, his wife and mother nursed him for four days, and there were three children in the house. At the place of employment there were five or six other employees. No further cases occurred at either place.

CASE K.—SMALL, IRENE.

Summary.—Female, æt. 16 years; single; domestic duties. No former attack; never inoculated. No communication with any previous case. Residence on outskirts of Ulmarra township, off the Coldstream-road, and about half a mile in a direct line from the post office. Attack on 26th January. Seen by me on the same day during inspection of residence. Admitted to Grafton Hospital on 28th January; discharged on 13th February; duration of illness, 19 days. Bubo, right femoral.

Movements before Attack.—She had not been away from Ulmarra for many weeks. Had been mostly occupied in and about the residence.

History of Illness.—26th January: Had been in good health previously; on this day, after breakfast, noticed tender spot in right groin; after lunch, noticed headache and felt cold; at 5·20 p.m. temperature, 100·2°; pulse, 120; bowels had acted yesterday and this morning; was up and about, but looked pale; at night restless, headache, and rigors. 27th January—Got up about 10 a.m., but head ached, and she felt ill; vomited during morning; at 1 p.m., temperature, 104·6°; pulse, 128; headache; "strawberry" tongue; tender femoral gland in right groin; 3 p.m., temperature same; injected Yersin serum, 40 c.c.; 9 p.m., temperature, 105·2°; vomited twice during the night. 28th January—8 a.m., temperature, 102·6°; pulse, 132; removed to Grafton, and admitted to hospital at noon; temperature, 4 p.m. 103°, 8 p.m. 102°;

pulse, 4 p.m. 120, 8 p.m. 116; slept comfortably at night. 29th January—Temperature, 8 a.m. 101·2°, 4 p.m. 104·2°, 8 p.m. 102·4°, pulse 8 a.m. 116, 4 p.m. 100, 8 p.m. 120; specimen obtained by puncture of bubo showed no bacilli in smear or culture; at night delirious and very restless, trying to get out of bed. 30th January—Temperature, 8 a.m. 102·8°, 8 p.m. 101°; pulse, 8 a.m. 120, 8 p.m. 120; at 9·40 a.m. 40 c.c. Yersin injected; severe headache in morning; more comfortable at night; slept well at night. 31st January: Temperature and pulse normal; slight rash on chest. 1st February—Normal temperature and pulse; from this onward her convalescence was uneventful, and on 13th February she was discharged.

Residence.—Consisted in part of a good, fairly new cottage, well raised off the ground, in part of a very old cottage, with floor joists embedded in the earth, and roof of shingles covered with iron. This older part contained two rooms used as a dining-room and bed-room respectively. The bed-room had been occupied by the patient on night of 24th January.

Rats.—On the evening of 24th January a sick rat was noticed just outside the dining-room. It was so feeble that one of the family put a tin over it, and brought word of the matter to one of my staff. Examination showed that it was plague infected. Next day, 25th January, I had the floors of the cottage taken up. One dead rat, plague infected, was found under the dining-room doorway, and the ground was riddled with rat runs. On 26th January, 2 infected and 1 putrid rat were found on the premises, and during the next four days as a result of thorough investigation which involved, amongst other things, the turning over of a barn full of hay, in all 20 plague-infected rats were obtained. Of these, 18 were found under the floor of a buggy shed situated about 200 yards from the house.

Contacts and further Cases.—The household usually comprised father, mother, three daughters, and two boys. No further cases occurred among these, but a brother of this patient who lived at a distance and came home at each week end was attacked (*vide* Case M).

CASE L.—MCCOOEY, JOHN.

Summary.—Male, æt. 53 years, married; carrier; no former attack; never inoculated; no communication with any previous case; no fixed residence or place of employment. Attack, 26th January; seen first by medical attendant on 27th January; died, 28th January, at 4 a.m.; duration of illness, 36 hours; case not notified until after death. Septicæmic plague confirmed by autopsy and by morphological and cultural tests.

Movements before Attack.—On 21st January he came to Ulmarra from Grafton. Stayed the night in Ulmarra, at Niland's. 22nd January—Returned to South Grafton for the night; stayed at Holmes's, South Grafton. On 23rd January returned to Ulmarra, and camped near McMillan's barn, on the river bank, about 1½ mile below Ulmarra. He had been engaged to remove the household effects of a family named McClennan, who were staying with the McMillans. These goods were stored in the barn, and McCooey was occupied on 23rd and 24th January in packing them on his dray. Each night he slept under his dray near the barn, and he complained at the time that he was "nearly eaten alive" by the fleas there. On January 25th, at daybreak, he started with the dray and furniture, and was on the road when attacked.

History of Illness (from information supplied by his friends).—26th January—While on the road, became very ill during the afternoon. Vomited, and complained of severe pain in the back. At night was delirious, and obviously very ill. During the night was conveyed by friends 10 miles to Laurence, and next morning (27th January) was taken by steamer to friend's house at South Grafton. 27th January—Seen at South Grafton by medical attendant during morning. Temperature then 102°. Vomiting had ceased. Spleen was found somewhat enlarged, but there was no bubo. A provisional diagnosis of influenza was made. During the day patient became worse again, pain in back returned and was very severe, and he was delirious. Condition was still worse at night. 28th January—Died at 4 a.m., after not more than 36 hours' illness. The case was now notified to me as possibly plague. *Post-mortem* examination, made 7½ hours after death, yielded the following information:—

Rigor mortis was well marked. Dependent parts, ears, and neck livid; skin showed many flea-bites, also many small subcutaneous *petechiæ*.

Abdomen.—Vessels of omentum were congested, and there were sub-serous hæmorrhages throughout the peritoneal cavity, on liver, kidneys, and intestinal walls; spleen greatly enlarged.

Thorax.—Pleural and pericardial fluid increased; no pleuritic adhesions; hæmorrhages on surface of lungs; lungs moderately congested.

Microscopic.—Smears from spleen showed abundant bipolar stained plague-like bacilli; cultures from spleen, liver, and heart's blood gave pure growths of *B. pestis.*

Residence.—As above described, he had no fixed abode for five days. The barn near which he was camped on 23rd and 24th January was fairly well constructed, with the "straddles" raised from the ground, but it was badly infested with fleas.

Rats.—At McMillan's, no history or dead or sick rats, and when the premises were turned out, on 31st January, very few rat runs, and no sign of recent infestation. The skeletons or mummies of 13 mice were found in the barn, and, in the same place, another mouse, still putrid. There was no indication of the cause of death of these mice. At Niland's, the only other Ulmarra premises where he was known to have been for any time, search was made, and traps were set on more than one occasion, but no rats were obtained.

Contacts and further Cases.—At McMillan's there was a household of five or six. No further cases occurred.

CASE M.—SMALL, ELLIS.

Summary.—Male, æt. 25 years, single; school-teacher; no former attack; never inoculated. Brother to Case K, but had not seen her since her attack. Resided and taught at Glenreagh, some 28 miles from Ulmarra, but returned home to Ulmarra each week end. Attacked, 27th January. Seen by me, 28th January; died, 1st February. Duration of illness, 5 days. Bubo, right cervical; morphological and cultural tests positive.

Movements before Attack.—On 21st January he came from Glenreagh to Ulmarra, and stayed at home till 2 p.m. on 22nd January, when he started on the return journey to Glenreagh; remained at Glenreagh till the morning of 28th January, when he started for Ulmarra, arriving home in the afternoon.

History of Illness.—26th January—Went to bed in his usual health. 27th January—On waking, "felt pains all over"; about 8·30 a.m. began vomiting, and this continued till afternoon; had some diarrhœa at same time; slept very little at night. 28th January—Still feeling ill, but drove 28 miles to his parents' residence at Ulmarra. Seen first by me at 3·45 p.m.; temperature, 103°; pulse, 120; tongue, clean; no bubo nor tenderness anywhere; headache; vomited again during the night. 29th January—11·30 a.m. temperature 102·4; headache gone; 2 p.m., temperature 103°, pulse 116; said he felt better; no bubo anywhere; blood taken this day from finger gave no bacilli in smear or culture; at night slept well, but vomited three times. 30th January—Noon, temperature 101°, pulse 106; has a small sore on right side of the neck, which is sloughing in the centre. 31st January—3·30 p.m., temperature 100·4°, pulse 102; felt better in every way, no more headache nor vomiting. The sore in neck above mentioned had been incised during the morning by his medical attendant, who subsequently informed me that only a few drops of dark blood escaped as a result; I did not see it, as it was freshly bandaged. His condition had obviously much improved in the last three days, and the only symptoms suggestive of plague were the sudden acute onset with vomiting, and the known exposure to risk of infection 5 days previously. (Case K was his sister, living at parents' residence, where he had been on 21st and 22nd January). Also, liver and spleen were found, on percussion, to be slightly enlarged. 1st February—After having had a fairly good night, but with some restlessness, he took a sudden change for the worse about 6·30 a.m., and when seen by his medical attendant at 8 a.m. was manifestly dying; he became rapidly weaker, though conscious to the last, and died at 9 a.m. Post-mortem examination at 11·30 a.m., 2½ hours after death; body already becoming livid, rigidity not well marked; on removing neck bandage, there was obvious a large brawny swelling over right sterno mastoid. His medical attendant, who was present at the autopsy, said there was no such swelling at noon the previous day, when he incised the sore as above described. On that occasion he was able to pinch up the affected skin in his fingers when making the cut. On opening the body, *liver* was enlarged and pale, no necrotic patches or hemorrhages; *spleen* was enlarged, smooth, and of fairly normal colour and consistence, no hemorrhages nor necrosis; *kidneys* fairly normal, no subserous hemorrhages; *lungs*, normal; *heart*, right side engorged, pericardial fluid much increased; *microscopic*—swelling in neck, smear showed abundant *B. pestis*, and culture was a pure growth of the same, similar bacilli were found in smears from liver (scanty), spleen (abundant), heart-blood (scanty). In this case it seems evident that the site of inoculation was the sore in the neck, which was, in fact, a plague carbuncle. The rapid formation of the swelling in the neck and fatal issue of the case within 24 hours of incision of this carbuncle, the course of the disease having previously tended definitely towards recovery, suggests the possibility that the incision may have been the means of introducing virulent bacilli into the blood-stream, and so producing septicæmia. Examination of blood taken from finger on 29th showed that at that date there were no bacilli in the blood.

Residence.—Glenreagh is a small and isolated village, and the school and residence clean and wel kept. The Ulmarra residence has already been described under Case K.

Rats.—At Glenreagh inquiries failed to show any evidence of epizootic plague. The evidence of epizootic plague at the Ulmarra home has already been given in regard to Case K.

Contacts and further Cases.—At Glenreagh, many contacts, but no further cases. At Ulmarra, *vide* under Case K.

CASE N.—CONNEAR MARTIN.

Summary.—Male, æt. 68 years, labourer; no former attack; never inoculated; no communication with any previous case. Residence and place of employment at D. K. McLachlan's, on Grafton Road, about 2 miles from Ulmarra. Attacked 6th May, at 10 a.m. Admitted to Grafton Hospital, 9th May; died, 10th May; duration of illness, 4½ days. Left femoral bubo. Morphological, cultural, and inoculation tests positive.

Movements prior to Attack.—Had come to D. K. McLachlan's four or five weeks before attack, and had not been away from the premises since then.

History of Illness (from information supplied by his medical attendants)—Had been subject to attacks of vomiting, probably due to dyspepsia. 6th May: About 10 a.m. he was attacked with vomiting, and became ill. 9th May: He was sent by his employer to Grafton Hospital, where he was found to have a left femoral bubo about the size of a walnut, severe headache, and temperature 104°; Yersin's serum 40 c.c. was injected at noon, and the condition improved somewhat; temperature, 8 p.m., 102·5°. 10th May: Temperature—4 a.m. 101·5°, during the day about 103°; at 4 p.m. Yersin's serum 40 c.c. injected; bubo had increased in size; about midnight patient died. 11th May: *Post-mortem* examination; surface of trunk and extremities presented many petechial spots of dark purple colour; the bubo was an ovoid swelling about 3 inches long, and with patches of ecchymosis in its upper part; intestinal walls showed innumerable subserous hæmorrhages, varying in size from a pin's head to a filbert; spleen was enlarged.

Cultures from the liver, made at the autopsy, were examined in the Board's laboratory and found to contain *B. pestis*, this finding being confirmed by inoculation of a guinea-pig.

Residence.—The patient and a lad occupied a wooden hut, detached, about 50 yards from the main dwelling.

Rats.—Careful search of the premises was made by an experienced Sanitary Inspector on 12th May and succeeding days, but no signs of rat-burrows could be found, nor was there any history of dead rats on the premises. One live rat was seen, but escaped, and 6 dead mice, 4 of which were swollen and putrid, and the other two skeletons. Examination of the neighbourhood showed that rats were very scarce. Eighty premises were searched in the week 13th 20th May, but the total catch was only—rats, 21; mice, 44. These were forwarded to me at Lismore, and on examination showed no signs of disease. Previous to the occurrence of this case, the last plague-infected rat found in the district had been found on 8th March, at J. Long's premises, on the Grafton–Ulmarra Road, a quarter of a mile from this patient's place of residence.

Contacts and further Cases.—No further case occurred.

Places of Residence.—Of the 13 persons attacked, 12 belonged to 9 different households, and 1 was a carrier with no fixed abode. One household produced 3 cases (Cases B, E, and F); another produced 2 (Cases K and L). But, as regards the probable place of infection, it was possible to group some of the cases more closely. Thus, Case A was a frequent visitor to the house of Case D, and was known to have in fact visited there 2½ days before her attack, and to have sat in the barn, where at the same period many dead and sick rats were being found. At her own home there were no indications or history of dead or sick rats. It is reasonable, therefore, to connect Case A with the place of residence of Case D, rather than with her own home.

Again, Case C resided in a perfectly new cottage, some 6 miles out of Ulmarra township, and away from the other cases. He was, however, a frequent visitor at the house of Cases B, E, and F; visited there on 25th and 28th December, and was attacked on evening of 29th December. Here also it is reasonable to exculpate his particular place of residence, and to connect him with the home which produced three other cases at the same time and within a period of 4 days.

Beyond the relations here indicated no connection could be traced between the cases as regards their probable source of infection, and it seems justifiable to suppose that the places of infection for the 13 cases were 8 in number, of which 1 produced 4 cases, 2 produced 2 each, while the other 5 cases received the infection at 5 different and separate places.

The place of residence of each case is shown in the map attached. It will be noted that as regards the first six cases which, in regard to time, form a group, or rather two sub-groups, preceding the next cases by 19 days, the adjudged places of infection, two in number, are on the river bank, some 1½ and 3 miles respectively below Ulmarra. The next, Case G, occurred in the township; Case H, at Cowper, some 6 miles below Ulmarra, still on the river bank; Case J, in the township; Cases K and M, on the outskirts of the township; and Case N, on the river bank, 2 miles above Ulmarra; while Case L had no fixed abode, but had within 72 hours of his attack slept two nights at a barn, also on the river bank, about 1 mile below Ulmarra.

Relationship with infected Persons.—As already pointed out there is no reason to suppose that any case of plague had occurred in the district prior to Case A. This patient had not been away from the district, and, consequently, could not have had any relations with any other infected person. Similarly with regard to Case B. He had not been away from the district, and had not seen Case A subsequent to her attack. Moreover, she died on 17th December, 12 days prior to the date on which he was attacked. Case C had been a frequent visitor at the home of Case B, but his last visit was on 28th December, when they were both in good health, and he was attacked on the evening of the same day as Case B, namely, on 29th December. Case D, attacked on 30th December, had no relations with either of the two preceding cases subsequent to their attack, and though he had been on intimate terms with Case A, was not attacked till 13 days after her death, a period which dispels any suspicion of infection directly from her. Cases E and F lived in the same house as Case B, and were attacked 15 hours and 82 hours respectively after his attack. Here the question of personal contagion cannot be put out of court at once as in the other cases, but it is worthy of note that Case B, the first of these three cases, was of a particularly mild type, and, on that account, the less likely to be capable of infecting others.

Case G was attacked 17 days after the death of Case F. He had had no relations with any infected persons. At the date of his attack the only persons in the district who could be placed in this category were Case B, who was convalescent and back at his ordinary work, and Case D, who was an inmate of a hospital at South Grafton. Moreover, Case G had seen neither of these persons for at least 10 days.

Case H was a semi-invalid maiden lady who lived with an aged father and a niece, and never went further from home than to her next-door neighbour, or to church. She had had no relations with any previous case.

As regards Case J, attacked 23rd January, 1905, it is possible that he visited Case G between the time of his attack on 21st January and his removal to hospital on 22nd January.

Case K, a girl of 16, had had no relations with any previous case.

Case L equally had had no such relations.

Case M was attacked on 27th January, about 24 hours after his sister, Case L, but he had not seen her since 22nd January, when they were both in usual health, and he had no relations with any other case, having, in fact, been 28 miles away teaching at a school.

It is thus clear that in this outbreak personal contact was not a factor in spreading the disease.

Relationship with infected Rodents.—The epizootic of plague among the rodents is dealt with in Part III of this Report. The relationship of human cases to infected rodents has been fully described above in the account of the circumstances connected with the individual cases.

Incubation Period.—In one case (Case M) it was possible to fix the period of incubation at between a maximum of 6 and a minimum of 5 days. This patient came from a distant place where there was no suspicion of infection, to his parents' home, where it was found a few days subsequent to his visit that there was epizoötic plague among the rodents, and where Case K (his sister) resided. He arrived about noon on 21st January, and stayed till 2 p.m. on 22nd January, when he departed for the aforesaid distant place. Here he was in good health and performing his usual duties as a school-teacher until 27th January, on which date he woke feeling out of sorts, and by 10 a.m. was definitely ill with vomiting and other symptoms.

PART III.

PLAGUE IN RATS.

From 8th January to 10th March, 1905, the dates on which operations during the first outbreak at Ulmarra were begun and ended, rodents to the number of 2,683 were examined at Ulmarra for evidence of plague infection. The following table shows the number of rats and mice examined, and the number found infected, week by week from Ulmarra, Woodford Island (including Brushgrove), Grafton, and South Grafton. From neither of the two last-mentioned places were infected rodents obtained:—

Week ending	Ulmarra.				Woodford Island.				Southgate.		Grafton.		S. Grafton.	
	Examined.		Infected.		Examined.		Infected.		Examined.		Examined.		Examined.	
	Rats.	Mice.	Rats.	Mice.	Rats.	Mice.	Rats.	Mice.	Rats.	Mice.	Rats.	Mice.	Rats.	Mice.
14 January ...	149	71	49	...	...	...	...	...	5	2	...	...	...	...
21 „ ...	45	2	...	...	8	...	...	...	51	...	34	15	2	...
28 „ ...	66	5	14	...	1	...	1	...	...	...	29	10	55	10
4 February ...	120	21	29	...	26	2	1	...	...	...	23	6	118	3
11 „ ...	176	69	2	2	63	15	3	1	...	...	33	7	2	3
18 „ ...	172	213	2	...	63	27	...	...	5	...	29	8	43	2
25 „ ...	206	95	4	...	37	4	...	...	...	...	37	10	2	...
4 March	121	47	...	...	55	7	...	...	...	...	31	13	1	...
11 „	73	33	1	...	...	...	...	...	5	...	18	16	3	...
	1,128	556	101	2	253	55	5	1	66	2	234	85	226	18

In addition to the rodents here tabulated, rats were examined from Laurence, 1; from Maclean, 1; from Harwood Island, 8; and from Woolgoolga, 50. From the first three of these places, which are situated on the Clarence River 6, 20, and 25 miles respectively below Ulmarra, none of the rats were found infected. Woolgoolga rats were, for convenience, examined at Ulmarra, but it is an entirely separate district, and is dealt with in another part of this report.

Of the conditions prevailing among the rats of the Ulmarra District prior to 8th January, nothing can with certainty be said, but from the information locally available, it appeared that rats had been unusually numerous some four to six weeks previously, *i.e.*, about the beginning of December, and that later on dead and sick rats had been seen at several places in the township and along the river bank. This mortality had been commented on, and had been loosely explained by the suggestion that the rats had been poisoned. I could not, however, hear of anyone who had actually laid poison at Ulmarra, and I learnt from the Mayor, who is also one of the principal storekeepers, that he had not sold more than two or three tins of rat poison in the past twelve months. So that there appeared little reason to suppose that poison had been used at all generally.

The rumour of rat mortality was not confined to the Ulmarra or right bank of the river. Similar statements were made with respect to the village of Southgate, on the left bank, opposite Ulmarra. Here a farmer named J. Donohoe stated to me that "before Christmas" he was overrun with rats. He laid some poison, but without much apparent effect. Between Christmas and New Year he began to find sick and dead rats. Easily killed the sick rats with a pitchfork. Picked up "some hundreds" of dead rats. The last dead rat found by him was found on 7th January, 1905. At my visit to the premises on 11th January, one dead mouse was found in an empty cottage and four dead rats in the barns, all, however, too far decomposed for bacteriological examination. During the following week 51 rats trapped in the neighbourhood of Southgate were examined, but none found infected, and no further mortality here was reported. The account given by Donohoe is strongly suggestive of an epizootic disease, but in the absence of direct bacteriological evidence, it is, perhaps, unsafe to say more than this. No human cases occurred at or were connected with Southgate, and no further rat mortality here or elsewhere on the left bank of the river was reported, with the exception that in May another farmer, H. McLachlan, residing on the left bank of the river some 4 miles above Southgate, reported that he had found dead mice at his farm, and submitted one of these for examination by me. The *post-mortem* appearances of this mouse were not, however, typical of plague, nor could conclusive bacteriological evidence be obtained. No further mortality among rats or mice here was reported.

In Ulmarra, the report of previous rat mortality was supported by the finding, on 9th and 10th January, of 50 rats and 65 mice mummified, in a barn at the residence of P.C. (Case D), and of 3 rats and 1 mouse in a similar condition at the place of residence of Cases B, E, and F. Under the existing climatic conditions—extremely hot, dry weather—this mummification would probably be produced in a week or ten days.

The second rat actually examined at Ulmarra was found to be plague-infected. This was on 8th January. The last infected rat was found on 8th March. In the 60 days thus delimited infected rats were found on 17 different premises in the municipality of Ulmarra, and on 3 premises in the adjoining village of Brushgrove, on Woodford Island. Plague infection was actually demonstrated in 106 rats and 3 mice. The infected rats were all of the *Decumanus* species. This is not contrary to previous experience in this State, but is, perhaps, worthy of mention, in view of the theory recently suggested (in *B. M. Journal* of 6/5/05) that *M. Decumanus* is naturally immune to plague. It should, however, also be stated that, of 1,128 rats examined at Ulmarra, 1,125 were *Decumanus* and 3 *Rattus*. On the other hand, of 234 rats from Grafton (where there were no cases nor infected rodents) 172 were *Decumanus* and 62 *Rattus*.

The number of demonstrably-infected rodents found on individual premises varied greatly. Thus, 10 premises furnished only 1 each, 1 furnished 2, 1 furnished 3, 3 furnished 4 each, 2 furnished 5, 1 furnished 6, and 2 premises 24 and 42 respectively. But, in most instances, the cleansing gang found also dead rodents which were too decomposed to permit of bacteriological diagnosis of the cause of death.

The following table is a list of the premises in which infected rodents, and 2 infected cats, were obtained, giving the number of infected rodents and also of rodents found dead, in which the cause of death could not be ascertained because they were too putrid. The order is the chronological order in which the premises were found to be infected :—

Week ending	Infected premises.	Infected rodents on such premises.	Other dead rodents.
14 January	Dr. Macky's, Ulmarra	Dec., 1	
	Brennan's "Exchange Hotel"	,, 12	Dec., 1
	P. Sullivan's, South Arm	,, 5	,, 2
21 ,,	None.		
28 ,,	Police Stables, Ulmarra	,, 5	,, 2
	T. Small's, ,,	,, 24	,, 1
	McMahon's Timber Yard	,, 4	,, 3
	W. Ensby's, Brushgrove	,, 1	
	Chinaman's Garden, Coldstream-road, Ulmarra.	Kitten, 1	
4 February	Hazzard's, Ulmarra	Dec., 3 ; Mus., 1	,, 4
	Mawhinney's, ,,	Dec., 6	,, 9
	O'Brien's, ,,	,, 1	
	C. E. Parsonage, Brushgrove	,, 1	
11 ,,	A. G. Bailey's, Ulmarra	Dec., 2 ; Mus., 1	Dec., 6 Mus.
	Daley's, Woodford Island	Cat, 1 ; Dec., 3 ; Mus., 1	Dec., 20
18 ,,	George Bailey's, Ulmarra	Dec., 1	Dec., 3 ; Mus., 3
	Northcote's, ,,	,, 1	Dec., 3
25 ,,	Joseph Bailey's, ,,	,, 1	,, 1
	J. T. Napper's, ,,	,, 2	,, 6
	Norman McLeod	,, 1	
4 March	None.		
11 ,,	J. Long	,, 1	,, 1

Origin of the Epizoötic.—Whence the *epizoötic* infection was introduced, and at what point in the district it first manifested itself can only be conjectured. As already described, Ulmarra has commercial relations with both Sydney and Brisbane —with the former by a regular semi-weekly service of steamers, in addition to occasional extra cargo boats, and with the latter by one weekly steamer. There is no overland trade. It is, therefore, necessary to examine the evidence of plague infection existing at Sydney and Brisbane about the time of the outbreak on the Clarence.

At Sydney plague-infected rodents had been obtained on 10th October, 1904, at 363, Sussex-street ; on 11th October, at Dalgety's Wharf ; on 4th November and 3rd December, at the A.U.S.N. Company's Wharf. After this last date, though the systematic rat examination was maintained, no more infected rats were brought in until 18th January, 1905, when 1 was obtained at the Sydney wharf of the North Coast Steam Navigation Company—the wharf, namely, at which the steamers from both the Clarence and Richmond rivers lie while discharging and loading cargo in Sydney. This was the first of 7 infected rats obtained from the same wharf on 18th, 19th, 23rd, 24th, and 25th January.

At Brisbane the official returns report finding of an infected rat on 8th October, 1904; but after this no more until 21st January, 1905, an interval of 105 days, during which, as far as is officially known, the town and port were free from plague in rats.

From this evidence as to known rat infection at the two places respectively—which, probably, however, cannot be accepted as fully and completely stating the actual conditions prevailing—and from the facts as to relative amounts of trade with Sydney and Brisbane, it would appear that the importation of infection from Sydney was more probable than from Brisbane.

The actual point or points at which the infection was introduced cannot be stated. The first human cases were associated with residences along the river bank between Ulmarra township and Cowper, a distance of 6 miles. The first evidence of mortality of rodents on a large scale was the finding of 50 rats and 65 mice mummified in Clarke's barn (Case D) situated on the river bank about 1½ miles below Ulmarra.

The first rat in which infection was demonstrated was found in Ulmarra on 8th January, 1905; but four days later, on 12th January, infected rats were found also in a cottage (P. Sullivan's), at South Arm, 7 miles below Ulmarra.

Thus there was evidence that by 12th January, 1905, rat plague had occurred along the river bank at Ulmarra, at South Arm, and at two intermediate places. There was as yet no evidence of its occurrence further away from the river bank.

The actual vehicle of the infection or infected rats could not be determined. Among the merchandise imported from Sydney were several kinds which might have served as a means of transporting rats, such as bales of empty bags and empty cases (egg and butter boxes). The imports from Brisbane were, generally speaking, of a less likely character.

The township of Ulmarra is served by the Ulmarra wharf which is used in common by both Sydney and Brisbane steamers. This wharf was also used by Clarke (Case D). The Plummers (Cases B, E, and F) and P. Sullivan, however, received their goods *viâ* the wharf at Brushgrove, a village at the western extremity of Woodford Island, where later on 3 premises were found infected.

The most probable theory as to the sequence of events appears to be that the infection was introduced at two points—Ulmarra and Brushgrove; that the epizootic spread first along the river bank, possibly because the rat population was more continuously distributed there than elsewhere; that it subsequently at Ulmarra spread through the township, and then from farm to farm in the immediate neighbourhood; that it manifested itself in a similar but to a much less degree at Brushgrove.

Special inquiry was made to determine whether the spread of infection was due to transported articles conveying infection or infected rats or to migration of the rats themselves. The evidence obtained, as well as the observed sequence of events, appeared to point conclusively to the latter. When once it had become known that plague-infected rats were being found in Ulmarra, a considerable amount of public alarm was caused, and every one was on the *qui vive* and fully alive to the necessity for preventing the importation to any premises of goods liable to convey rats. I could not learn that as regards any premises which were found infected any articles had recently been imported thither from other infected premises.

Migration was no doubt facilitated by the fact that nearly all the fields round the town were carrying a heavy crop of maize, which at that time was nearly ripe. These fields afforded shelter and also food, and through them there was for the rat an undisturbed path from one farm to another. At the same time they rendered hopeless any attempt to exterminate the rats by any measures short of destroying all the crops. The operations of the cleansing gangs were, therefore, confined to dealing with residences, barns, pigsties, and their immediate environment, destroying rats and their burrows, and as far as possible amending those conditions about the premises which afforded harbourage to rats.

These measures were vigorously carried out, and are described in more detail in Part IV of this Report. The epizootic appeared to gradually die down, the last infected rat was obtained on 8th March, and no further rat mortality was reported from any part of the district. Moreover, when some two months later search for rats was reinstituted in connection with another case of plague, it was found that rats were still exceedingly scarce.

The occurrence of rat plague at Brushgrove requires separate mention as this place is a village on Woodford Island, separated from the Ulmarra shore by the south arm of the Clarance—a navigable channel of considerable size. Communication with the right bank of the river is by punt from Brushgrove to Cowper. At Brushgrove is a public wharf used by the ocean steamers, and the neighbouring farmers on the mainland get their goods by this wharf as being more convenient than the Ulmarra wharf.

On 27th January, 1905, an infected rat was obtained from W. Ensby's residence in the village of Brushgrove. Prior to this there had been statements on good authority that dead rats had been found in the vicinity of the wharf. These were said to have been thrown into the river by persons who feared quarantine of their wharf. Ensby's residence is in the vicinity of the ocean steamers' wharf, and between this and the punt connecting with Cowper. Four days later another infected rat was found on Scott's premises in the same neighbourhood, rather nearer to the wharf. Systematic cleansing operations had meanwhile been instituted, and all rats obtainable submitted for examination. There were, however, no further indications of plague until 9th February, when two infected and seventeen putrid rats were found at Daley's farm, Woodford Island, about 1 mile from Brushgrove. Next day an infected rat and mouse and 3 putrid rats and an infected cat were obtained on the same premises. Daley had had no goods capable of transporting rats since six months ago, when he had some chaff from Sussex-street. I was, therefore, forced to conclude that the plague rats had reached his farm by migration. This was remarkable, as the country between his farm and Brushgrove was mostly open grazing land with some maize fields, and there had been no indications of infection at other places along the road.

The measures adopted here were the same as at Ulmarra. In all, 253 rats and 55 mice were examined without any further discovery of infection, and, besides these, many rats, probably hundreds, had been destroyed by the farmers, now thoroughly alive to the danger threatening them.

Plague in Animals other than Rats and Mice.—In view of observations recorded in other parts of the world as to susceptibility of domestic animals generally, the staff were instructed to investigate any information received which might bear on this question. Nowhere, however, was there any unusual sickness or mortality, with the exception that plague-infection was detected in 2 cats. One of these was a kitten found dead on 31st January at a Chinaman's residence in Ulmarra; the other a full-grown cat obtained on 10th February at Daley's farm, Brushgrove. This latter had been noticed to be sick and was killed for examination. In both these were found the changes usually characterising plague in cats, viz., enlargement of submaxillary glands, from which pure culture of *B. pestis* was obtained, and signs of general, but not acute, infection of other organs.

PART

PART IV.

ADMINISTRATIVE MEASURES.

The administrative measures adopted may be described under the following headings:—

1. Hospital accommodation and treatment.
2. The epizoötic. Operations for destruction of rats.
3. Quarantine measures for the protection of other parts of the District and of the State.

1. *Hospital Accommodation and Treatment.*

ON my arrival in the district I found Case B convalescent, and needing no further hospital treatment, and Case D under treatment in a private hospital at South Grafton. As regards the latter patient, there seemed no necessity nor justification for removing him. Our Sydney experience had shown that the risk of infection from a patient suffering from bubonic plague is probably a negligible quantity, and this patient was under most satisfactory conditions as regards surroundings. It seemed advisable, however, to obtain the services of nurses who had had previous plague experience, not only on account of this patient, but because there was a probability of further cases occurring, and at my request two nurses were sent up by the Department and arrived on 9th January.

The next requisite was to find hospital accommodation for other cases that might occur. Ulmarra itself offered no prospects of a suitable establishment there. No suitable buildings were available, difficulties as regards medical attendance and necessary supplies appeared probable, and it seemed highly improper to establish a hospital in a district where epizootic plague was known to exist. Moreover, it seemed *primâ facie* probable that if there were going to be an epidemic the majority of the cases would occur at Grafton, which is the largest centre of population, and, as the terminal port of the ocean steamers, more exposed to risks of infection than the down river towns, since the steamers lie two nights and a day at Grafton, whereas at the other wharves they merely call to discharge cargo and passengers.

There were several reasons against improvising a temporary hospital anywhere. One, that in such an institution, hastily organised, it would be difficult to provide as satisfactorily for the nursing and comfort of the patient as in a permanent hospital already staffed and in working order. Another reason against a temporary hospital was the probability that sporadic cases would continue to occur in the district for some time, and that it would be necessary on this account to maintain the hospital in an efficient state long after cases had ceased to occur. There was the further reason that it was eminently desirable, in view of the possibility of such sporadic cases in the future, that the medical and nursing staff of the District Hospital should be afforded an opportunity of familiarising themselves to some extent with the disease.

On these grounds it was decided ultimately that the best course would be to utilise the District Hospital situated at Grafton, and which is subsidised by the Government to serve the needs of Grafton and district, including Ulmarra.

This decision of the Department met, at first, with considerable opposition on the part of the Grafton public, amongst whom the outbreak of plague in the district had, not unnaturally, caused somewhat of a scare. However, the Department had the support of the medical profession of the district, and of the Hospital Committee, and after no great time the general public began to accept the assurance that the presence of plague patients in the hospital was no danger to the town, and to realise that the course pursued was right. The hospital is situated on the outskirts of the town, over a mile from the Post-office. It contains twenty-nine beds for general, medical, and surgical cases in the main building, and three beds in two wards in a small detached wooden building, some 100 yards from the other wards. This detached building was used for the plague cases, and also a small two-bed ward in the main building, which being on the ground floor, and approached only by a back verandah, was to this extent isolated from the rest of the wards. The nurses who attended the plague patients were not isolated in any way, but were quartered and had their meals with the rest of the nursing staff.

To supplement the accommodation at the hospital, a wooden ward, 40 feet x 20 feet, capable of accommodating five beds, was erected at the expense of the Department for £125 10s., and the Department sent up from Sydney beds, bedding, and other equipment for five patients and two nurses.

The staff of the hospital was also supplemented, at the expense of the Department, by four nurses who had had previous plague experience. The hospital being fortunate in the possession of a Matron (Nurse M. A. Coghlan) of exceptional tact and administrative capacity, these arrangements all worked with the utmost smoothness, and there was at the same time no hitch in carrying on as usual the ordinary business of the hospital.

For the medical care of the plague patients it was necessary to make a special arrangement, as the patients of some of the honorary medical staff objected, in the first scare, to the idea of sharing their medical attendant with a plague patient. Accordingly, Dr. Earl Page, who had already charge in his hospital of Case D, was appointed to this position.

2. *The Epizoötic—Operations for Destruction of Rats.*

The first work to be done on arrival at Ulmarra was the turning out and disinfection of premises occupied by previous plague patients. While this work was in progress, under the immediate supervision of the Department's Sanitary Inspector, rats were being examined from as many places as possible, and indications thus obtained as to where the cleansing operations should be continued.

An attempt was made, at the outset, to have the work done by the householders concerned, under skilled supervision; but soon it was found that progress was very slow with this arrangement, and it was considered better to engage a gang of labourers, who worked with two experienced gangers sent up by the Department on 30th January.

The plan of campaign adopted at first was to deal especially with premises found to be infected, and premises in the immediate neighbourhood of these. But when there developed indications of widespread and spreading infection, it was deemed advisable to work on a more comprehensive scheme. Accordingly, at my request, the Department sent up, on 6th February, two more gangers and eight labourers who had had previous experience in plague work.

With the local labour engaged, there were now available 4 gangers and 15 labourers, and these were disposed as follows:—1 ganger and 4 men at Brushgrove, to work thence along Woodford Island; 1 ganger and 4 men to work from the Coldstream River upstream to Ulmarra; a similar party to start from about 3 miles above Ulmarra, and work downstream to meet No. 2; and a fourth party, consisting of a ganger and 3 men, to work the premises more remote from the river bank.

In this way was effected a house-to-house visitation of all premises in the Municipality, except some lying far out in the south and south-west, which were considered to be fairly secure from infection by reason of their remoteness. On these also, however, much was eventually done by the farmers themselves to destroy rats and clean up generally.

The kind of work done by these gangs has already been described. In Ulmarra, 207 premises, out of a total in the Municipality of 291, were thus dealt with. On Woodford Island the operations were extended 8 miles down-stream from Brushgrove, and 108 premises in all were cleansed and searched for rats.

This work was brought to a close in Woodford Island on 4th March, and in Ulmarra a week later.

Measures adopted in other parts of the District.—While operations were in progress at Ulmarra considerable anxiety was naturally felt in the surrounding districts lest the epizoötic should spread there also.

Grafton and South Grafton seemed especially likely places, as being much larger centres of population, and exposed to risks of importation of plague rats in a much greater degree than Ulmarra. Accordingly an experienced rat-catcher was detailed to trap in these two places, and his catch was forwarded once or twice daily to Ulmarra to be examined. From Grafton 234 rats and 85 mice, and from South Grafton 226 rats and 18 mice, were thus obtained, but none showed any signs of infection.

At the same time instructions were issued to the police in all the surrounding patrol districts to immediately report any unusual mortality among rats or mice. Several rumours of such mortality which reached us were promptly investigated by the police, but in none was there any justification for suspicion of plague.

One rat obtained from Laurence Post Office showed some suspicious bacilli, but it was partially putrid, and the examination was therefore unsatisfactory. No further rats could be obtained from this place.

The local authorities at Grafton and Maclean, above and below Ulmarra, were advised as to the kind of preventive action required, and took vigorous measures to clean up premises, remove accumulations of rubbish, and get rid of rats. At the same time a Departmental pamphlet of instructions was freely distributed to householders; and a proclamation by the Governor, calling on all persons to report any unusual mortality amongst rats, was displayed in all public places and published in the local press.

3. *Quarantine and Restriction of Trade.*

Prior to my arrival, and when a degree of panic prevailed locally on account of the outbreak, some quarantine had been imposed by the police authorities on the residences of the early cases. It was not, however, considered necessary to continue this, nor to adopt the same course with regard to other premises, with the exception of the "Exchange Hotel," at Ulmarra. Here plague rats were found on 11th January, and, as the place was dirty and rat-infested, it was decided that the general public, for their own protection, should be excluded until the cleansing operations were finished. The hotel was accordingly closed from 12th to 14th January, but the persons resident on the premises were not restrained in going in and out. The result of the work was the finding of 42 infected rats in the stables and outhouses, and the removal of many cartloads of rubbish.

Trade restrictions in regard to Ulmarra were imposed from 6th January, in terms of an Executive minute of that date, which authorised "Prevention of the transport by steamer of grain and fodder from Ulmarra, and from such places on the Clarence River as may hereafter be declared to be infected with bubonic plague, except when it is intended to bring such grain and fodder direct to Sydney or to take it outside the State."

Similar restrictions were extended to Woodford Island on the finding there of an infected rat on 27th January.

Maize being one of the principal products of the Ulmarra district, this prohibition was a serious matter for the farmers, whose crops were just ripening and ready to be gathered. However, an arrangement was made by which a cargo steamer was detailed by the North Coast Steam Navigation Company to serve the quarantined wharfs—Ulmarra, and subsequently Brushgrove—only, taking cargo from these direct to Sydney, where she lay in the stream and was unloaded into lighters; and on the 2nd February, 1905, the restrictions were modified to the extent of permitting the removal of grain only, under the above conditions, an addition being made to the instructions as follows:—"Fodder may not be removed within or out of the infected district under any circumstances." Meanwhile the other regular steamers ceased to call at Ulmarra, and any freight (other than fodder or grain) and passengers were conveyed from Ulmarra by a tender and transhipped at a plague-free wharf. It was not considered necessary to place any restrictions on the export of butter, which, being packed solidly in cubical boxes (1 foot each way), was not capable of carrying rats. This was of great importance, as the manufacture of butter is the staple industry of the district.

The restrictions were removed on completion of the cleansing operations, namely, as regards Woodford Island, excepting Brushgrove, on 28th February, 1905, and as regards Brushgrove and Ulmarra on 16th March, 1905.

PREPARED FOR THE DEPARTMENT OF PUBLIC HEALTH.

MAP
OF THE
PARISH OF ULMARRA, COUNTY OF CLARENCE.

Showing the places at which plague-infected rodents were taken in 1905, and the places of residence of the persons who had plague.

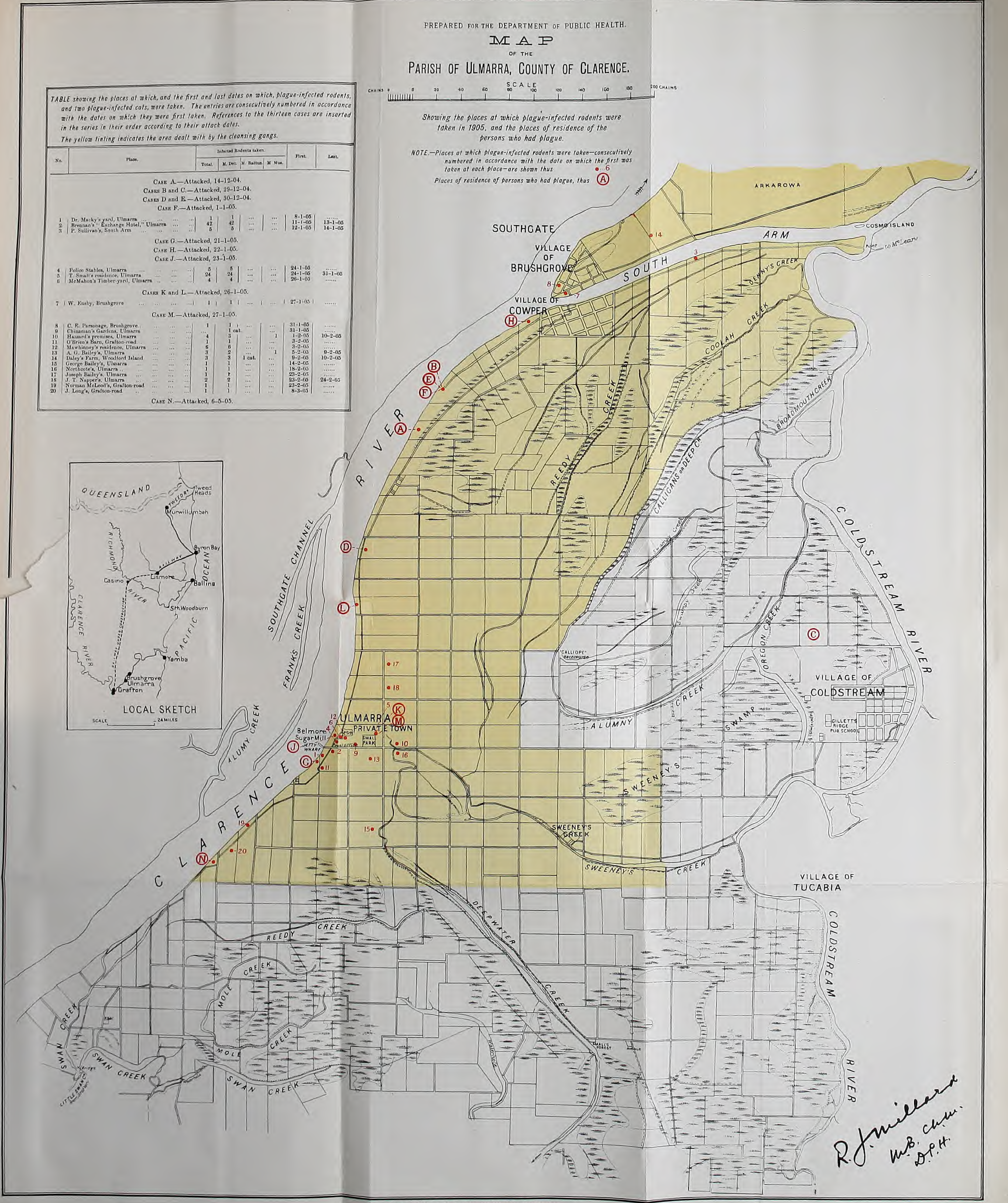
NOTE.—Places at which plague-infected rodents were taken—consecutively numbered in accordance with the date on which the first was taken at each place—are shown thus ●..6

Places of residence of persons who had plague, thus Ⓐ

TABLE showing the places at which, and the first and last dates on which, plague-infected rodents, and two plague-infected cats, were taken. The entries are consecutively numbered in accordance with the dates on which they were first taken. References to the thirteen cases are inserted in the series in their order according to their attack dates.

The yellow tinting indicates the area dealt with by the cleansing gangs.

No.	Place.	Infected Rodents taken.				First.	Last.
		Total.	M. Dec.	M. Rattus.	M. Mus.		
	CASE A.—Attacked, 14-12-04.						
	CASES B and C.—Attacked, 29-12-04.						
	CASES D and E.—Attacked, 30-12-04.						
	CASE F.—Attacked, 1-1-05.						
1	Dr. Macky's yard, Ulmarra	1	1	...	...	8-1-05	......
2	Brennan's "Exchange Hotel," Ulmarra	42	42	...	...	11-1-05	13-1-05
3	P. Sullivan's, South Arm	5	5	...	...	12-1-05	14-1-05
	CASE G.—Attacked, 21-1-05.						
	CASE H.—Attacked, 22-1-05.						
	CASE J.—Attacked, 23-1-05.						
4	Police Stables, Ulmarra	5	5	...	...	24-1-05	......
5	T. Small's residence, Ulmarra	24	24	...	...	24-1-05	31-1-05
6	McMahon's Timber-yard, Ulmarra	4	4	...	...	26-1-05	......
	CASES K and L.—Attacked, 26-1-05.						
7	W. Ensby, Brushgrove	1	1	...	...	27-1-05	......
	CASE M.—Attacked, 27-1-05.						
8	C. E. Parsonage, Brushgrove..	1	1	...	...	31-1-05	......
9	Chinaman's Gardens, Ulmarra	...	1 cat.		...	31-1-05	......
10	Hazzard's premises, Ulmarra	4	3	...	1	1-2-05	10-2-05
11	O'Brien's Barn, Grafton-road	1	1	...	...	3-2-05	......
12	Mawhinney's residence, Ulmarra	6	6	...	...	3-2-05	......
13	A. G. Bailey's, Ulmarra	3	2	...	1	5-2-05	9-2-05
14	Daley's Farm, Woodford Island	3	3	1 cat.	...	9-2-05	10-2-05
15	George Bailey's, Ulmarra	1	1	...	...	14-2-05	......
16	Northcote's, Ulmarra	1	1	...	...	18-2-05	......
17	Joseph Bailey's, Ulmarra	1	1	...	...	23-2-05	......
18	J. T. Napper's, Ulmarra	2	2	...	...	23-2-05	24-2-05
19	Norman McLeod's, Grafton-road	1	1	...	...	23-2-05	......
20	J. Long's, Grafton-road	1	1	...	...	8-3-03	......
	CASE N.—Attacked, 6-5-05.						



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THE EPIZOÖTIC AT WOOLGOOLGA.

Woolgoolga is a small township of about fifty houses, situated on the sea-coast about 45 miles south of the entrance to the Clarence River and about 250 miles north of Sydney, and by road about 30 miles from South Grafton. The principal industry is timber getting, and there are two large saw-mills. There is no harbour, but a massive wooden jetty 500 yards long runs out from the beach. Vessels lie alongside but not in contact with this jetty, and goods and passengers are hoisted out by a steam crane. All trade is by sea. Four small steamers trade from Sydney (eastern side of Darling Harbour) to Newcastle, Coff's Harbour, Woolgoolga, Byron Bay, and the Tweed River every week, calling at Woolgoolga coming and going. There are no trade relations with the Clarence River. The exports from Woolgoolga consist chiefly of timber, with a small amount of farm produce. The imports are general stores and forage, together with empty egg cases and poultry coops. (N.B.—It was learned that not infrequently rats were landed in these returned empty cases.)

On 1st February, 1905, the Woolgoolga police reported to me at Ulmarra that a rat "had fallen from the roof of a cottage ceiling in Woolgoolga, had appeared sick, and died shortly after." By my request the specimen was forwarded to me for examination, and I received it on the 2nd February, some thirty hours after death. It was then already partly decomposed, and had been struck or crushed, with the result that the liver and spleen were smashed. Examination showed some hæmorrhages in the uninjured portions of the internal organs, and smears made from the spleen contained (among putrefactive organisms) numerous bacilli having the morphological and staining characteristics of the *B. pestis*. Cultures were made but were useless for diagnostic purposes as they became overgrown with putrefactive organisms.

The circumstances under which this rat had been obtained and the microscopical examination, indicated a necessity for further investigation, and accordingly a sanitary inspector and three rat-catchers were sent by the Department from Sydney for this purpose. I visited Woolgoolga on 6th February, and the rat-catching staff operated there 8–11th February, under the direction of the sanitary inspector, who forwarded the rats obtained to Ulmarra for examination.

The premises from which the first specimen had been obtained were situated about 300 yards from the jetty, and like most of the other premises in the neighbourhood of the jetty showed abundant signs of rat infestation. No other dead or sick rats, however, were found or heard of by the staff, and the total number of rats trapped or killed was only 49, including 5 from the abovementioned premises. None of these rats were found infected.

No cases among human beings were in any way connected with Woolgoolga.

It must be admitted that the evidence of the existence of the epizootic at Woolgoolga is meagre and unsatisfactory, and under these circumstances it is probably not worth while to discuss the possible sources whence the infection might have been introduced.

THE OUTBREAK ON THE RICHMOND RIVER.

A. Ballina.

Part I.

General Description of Ballina.

Ballina is the seaport at the mouth of the Richmond River, 331 miles north of Sydney, about 35 miles north of the mouth of the Clarence River, and about 70 miles south of Brisbane. On the Richmond River, many miles upstream, are situated the towns of Lismore, Casino, and Coraki, as well as the townships of Woodburn, Wardell, and many other smaller settlements.

The municipality of Ballina had at the Census of 1901 a population of 1,819, and contained 324 dwellings, of which it is recorded that 304 were of wood, and 209 contained five or more rooms. These figures are probably approximately correct at the present time.

The site of the town is almost uniformly flat, and little raised above sea level. The soil is sandy, and some areas formerly under water have been reclaimed by means of a sand-pump. Near the mouth of the river two arms join, the town being situated in the angle thus formed, and a canal has been cut from one arm to the other at the back of the town which is in this way surrounded on all sides by water.

Water supply is abundant and good, being led in pipes from a waterfall distant some miles out of town.

Sewerage there is none, with one exception, of importance in relation to the subject of this report. This exception is a storm-water drain about 8 chains in length, constructed of Monier pipes, about 3 feet in diameter at the outlet, which runs down Cherry-street to the harbour front. This takes surface waters from the street gutters, but also has connected to it the drains from Webster's Hotel (at the corner of Cherry and River streets), from an adjoining "Coffee Palace" in Cherry-street, and from Webster's-lane, which separates the "Coffee Palace" from Webster's stables in Cherry-street. The drains from Webster's Hotel and from the "Coffee Palace" are trapped, but that from the lane is not, and the inlet here is merely protected by an iron grating, the openings in which are sufficiently wide to permit the passage of a rat.

The town has a frontage to the river of about 1½ mile, which is composed of rough, loose stone-work. There are also extensive breakwaters and training-walls at the mouth of the river, constructed at great expense to improve the entrance, which is obstructed by a sandy bar. These are of the same rough, loose stone-work.

Trade, Industries, &c.—The town serves a large district, in which sugar-growing and dairying are the main industries. There is a large butter-factory and a large saw-mill on the river bank. Sugar-cane is taken to the Sugar Company's works, some 15 miles upstream.

Communication.—Ballina is connected by regular steamers with both Sydney and Brisbane. To the former, three steamers of the North Coast Steam Navigation Company run every week, in addition to fairly frequent extra cargo boats. With Brisbane and with the Clarence River, trade is connected with the s.s. "Pyrmont," which runs once a week to the Clarence River, and calls in at the Richmond River both going and returning. Besides these, there are some irregular traders, mostly timber-carriers. Local trade with places up the river is conducted by five or six small steamers, which ply up and down daily, carrying passengers and stores, as well as cream and other farm produce. The ocean boats above mentioned also go up the river, all of them to Coraki, 40 miles, and most of them to Lismore, 62 miles above the mouth of the river. Going and coming they lie at the Ballina wharves for varying periods, according to the cargo to be dealt with.

PART II.

PLAGUE IN MAN.

In all, 4 cases of plague occurred at Ballina, the attack dates being as follow:—

Case A.—Esther Nicholls, attacked 3rd February, 1905.

Case B.—John Day, attacked 22nd April, 1905.

Case C.—Elizabeth Wallbridge, attacked 2nd May, 1905.

Case D.—Mary Koorey, attacked 28th May, 1905.

Thus a period of 16 weeks was included between the date of the first and the date of the fourth attack, and the three intervals between successive cases were 11 weeks, 10 days, and 26 days. From the available information concerning the epizoötic, meagre though it is, it is probable that during the whole of this period of 16 weeks there were plague-infected rats in Ballina, and it is at least noteworthy that the cases should have been so few and chronologically so scattered. It should be added, too, that of these 4 cases, one (Case B) almost certainly received his infection, not in Ballina, but on a farm 5 miles out of town.

There was no reason to believe that any cases occurred other than those here described.

The circumstances surrounding the above-mentioned cases were in detail as follows:—

CASE A.—NICHOLLS, ESTHER.

Summary.—F., æt. 60 years, widow, domestic duties. No previous attack; never inoculated; no communication with any previous case. Residence, at her son's bakery in River-street. Attacked, 3rd February, 1905; notified by her medical attendant on 10th February; visited by me on 11th February; died, 14th February; duration of illness, 11 days. Right femoral bubo; morphological, cultural, and inoculation tests positive.

Movements before Attack.—Had not been away from Ballina for many weeks; spent most of her time at home doing small items of housework.

History of Illness.—3rd February—Having been previously in her ordinary fairly good health, on this date she vomited after doing a little washing, and had severe headache. 4th February—Seen in morning by her medical attendant, who found temperature between 101° and 102°. Admitted to Ballina Hospital about noon. Very dull; unable to give any account of herself, except that she had bad headache. Temperature at noon, 104°; at 4 p.m., 105·4°. After admission to hospital remained in a dull, semi-stuporous condition. Temperature each morning 102° to 103°, and each evening 103° to 104°. Tongue, at first creamy, became dry and brown. 9th February—Bubo first discovered as a small lump in right Scarpa's triangle, and extending above Poupart's ligament; slightly tender on palpation. No lesion on the drainage area of the glands involved was perceptible at that date. Fluid obtained by puncture of bubo with hypodermic needle showed numerous bipolar stained bacilli of same size and shape as *B. pestis*, and on cultural and inoculation tests with this fluid positive results were obtained. Temperature on 11th February was—in the morning 99·4°, and in the evening 100·4°. From this time the temperature kept down to about normal, and the mental condition became clearer; but she slept badly, and did not take her food well. 14th February—Became gradually weaker, and about 8 p.m. died. Autopsy, about eleven hours after death; rigor mortis well marked; no *post-mortem* lividity; no petechial hæmorrhages. Chest—Lungs healthy; some hypostatic congestion; no adhesions; heart walls thin and flabby; no valvular incompetence. Abdomen—Organs generally moderately loaded with fat; liver, fatty, not enlarged; spleen, normal in size, appearance, and consistence; kidneys showed evidence of old-standing chronic disease; cortex very much diminished; parenchyma generally pale and fibrosed; small ecchymoses under capsule. Bubo of the vertical group of inguinal glands.

Residence.—The premises comprised a shop and dwelling rooms, with bake-house at the rear, and a yard which extended past some hotel stables debouching on the harbour front at the point occupied by the Brisbane Wharf, *i.e.*, the wharf used by the s.s. "Pyrmont," trading to and from Brisbane. The buildings were of weatherboard, old, and in bad repair. In the bake-house the floor joists had rotted, and the floor planks were resting on the earth.

Rats.—Patient's son, the baker, occupying the premises, stated that he had found several dead rats about the place, the last, he believed, on 21st January (thirteen days before the alleged date of attack of this case). When these premises were turned out by the cleansing staff on 16th February, and later, abundant indications were found of previous rat infestation but no dead rats, nor could any rats be trapped here.

CASE B.—DAY, JOHN.

Summary.—Male, æt. 19 years, single, farm labourer and vendor of vegetables. No previous attack; never inoculated; no communication with any previous case. Residence and place of employment, John Kempnich's farm, about 5 miles north of Ballina. Attacked 22nd April, 1905; to hospital, 25th April; died, 28th April; duration of illness, 5½ days. Right inguinal bubo; morphological, cultural, and inoculation tests applied to bubo fluid with positive results. Blood from patient's ear, obtained twelve hours before death, was inoculated with fatal results into a guinea-pig, from which plague bacilli were then recovered.

Movements before Attack.—He was principally employed about Kempnich's farm, but went twice a week to Ballina to sell vegetables, and on the date of attack had spent the evening at Ballina.

History of Illness.—22nd April—While in Ballina spending Saturday evening he felt unwell about 10 p.m. and returned home. About midnight complained of aching in right leg and groin and of frontal headache; was feverish and chilly, and vomited. 23rd to 24th April—Worse; semi-unconscious at times. On 24th, about 8 p.m., seen by Dr. Corlis, who found temperature 102° and pulse 110, and glands of right groin enlarged and tender. 25th April—Removed to Ballina Hospital in morning; temperature in morning, 103°; evening, 104·6°; pulse, 120°; severe headache; bubo larger and more painful. 26th April—Temperature in morning, 102°; evening, 104·6°; pulse, 120; complaining of pain in abdomen. 27th April—Restless and delirious; temperature, 103·6°. 28th April—Morning temperature, 104·2°; pulse, 132; very feeble; about 8 a.m., died.

Residence and Place of Employment.—The premises were ill-constructed and ill-kept. The patient, with three other men, slept in a room under the same roof with and adjoining a stable, and a store-room in which paspalum grass seed, and maize and other forage were stored.

Rats.—Three dead rats had been found on the premises about two weeks before the patient was attacked, and, when cleansing operations were carried out on 27th April (5 days after the date of attack), 16 dead rats and 23 dead mice were found, and several more were killed. Of these, 2 rats and 3 mice were demonstrably plague-infected. The distance from Ballina, about 5 miles, made it unlikely that the infection had reached this farm by migration of rats; and it appeared more probable that infected rats had been transported from Ballina in bundles of sacks, empty cases, or such like. Kempnich sent fruit regularly to Ballina, and also considerable quantities of paspalum seed, the latter in sacks. Thus, in the course of his business, he received from the town empty cases and empty sacks; and it was learned that, as a matter of fact, he had received a consignment of fifty sacks from Nicholls' bakery during the week prior to the attack of Esther Nicholls (Case A) on 3rd February, 1905. Under these circumstances, there were ample facilities for the transport of rats from Ballina. Just when the epizootic at Kempnich's farm began is not indicated by the available evidence. Close questioning after the occurrence of the case elicited the information that three dead rats had been found about the beginning of April, and it is not improbable that the rat mortality may have begun very much earlier without attracting much attention from the farmer and his labourers, who would not appreciate its significance.

CASE C.—WALLBRIDGE, ELIZABETH.

Summary.—Female, æt. 22 years, single, domestic servant; residence and employment, Commercial Bank, River-street, Ballina; no former attack; not inoculated; no communication with any previous case; attacked 2nd May, 1905; to hospital, 4th May; died, 9th May; duration of illness, 7 days; bubo, right axillary.

Movements before Attack.—She had not been away from Ballina for many weeks. Had gone about the town as usual.

History of Illness.—2nd May—The onset was sudden, with headache and pyrexia. 4th May—Developed a right axillary bubo, and, plague being then diagnosed, was removed to Ballina Hospital; here she made no improvement, the bubo increased, and the pyrexia continued. 9th May—Died.

Residence and Employment.—The Bank premises, a wooden building, were clean and well kept.

Rats.—No evidence of rat infestation was found on the Bank premises where she resided and was employed, nor had any dead rats been found there; but these premises are situated in a block in which plague-infected rats were found, both before and after the occurrence of this case. The back of the Bank premises abuts on Webster's-lane, only a few yards west of Webster's stables, where infected rats had been found on 14th and 15th February, and east of Martin and Williamson's produce store, in which infected rats were found on May 17th, a fortnight after her attack.

CASE D.—KOOREY, MARY.

Summary.—Female, æt. 21 years, wife of a small draper; employed at home in domestic duties; no previous attack; never inoculated; no communication with any previous case; resided on the shop premises in River-street, Ballina; attacked 28th May, 1905; diagnosed, 30th May, removed to hospital, 31st May; discharged, 23rd June; duration of illness, 26 days; right femoral bubo—morphological and cultural tests positive.

Movements before Attack.—Had been on a visit to Sydney, and returned thence on 21st May, 1905. Subsequent to return, was mainly occupied about her place of residence.

History of Illness.—28th May—First felt out of sorts, but was able to go for a Sunday afternoon walk. 29th May—In bed all day with headache; vomited during the day; at night felt pain in right femoral gland. 30th May—At 12·45 p.m. her medical attendant found temperature 105°, severe headache, and a definite right femoral bubo; seen by me at 5·15 p.m.; tongue moist and clean; complained most of headache; temperature, 104·4°; pulse, 126; diffuse swelling in right Scarpa's triangle, in which could be felt an enlarged and tender gland about the size of a small walnut; fluid obtained by puncture of this bubo contained abundant bipolar stained bacilli, and on Agar gave a pure culture of *B. pestis*; at 7·30 p.m. 60 c.c. of Yersin's serum were given; at 10 p.m. sleeping, with temperature of 103·6°; pulse, 106; respiration, 24. 31st May—Temperature, 103°; pulse, 120; bubo about the same; removed to hospital at 10 a.m.; vomited at intervals through the day; at 11·30 a.m. Yersin's serum 80 c.c. 1st June—Temperature, morning, 99°; evening, 100°; pulse, 90; bubo less tender and not so large. After this her progress towards recovery was uninterrupted, the temperature did not again rise above 100°, and the bubo gradually resolved without suppuration. 23rd June—Discharged from hospital cured.

Residence.—The draper's shop and the dwelling rooms behind it were clean, but built of wood, and situated next door to Martin and Williamson's produce store, with which they were structurally almost continuous.

Rats.—There were rat runs communicating freely between Martin and Williamson's produce store next door and the residence. On 17th May 4 plague-infected rats were found dead in the produce store; and on 19th May, during the cleansing operations instituted in consequence of this discovery, 1 more plague-infected rat was obtained. At the same date, the adjoining premises, including those occupied by the patient's husband, were searched for rats unsuccessfully, nor was any history of dead rats about Koorey's premises obtained either then or subsequently; but abundant traces of rats were found, especially above the ceilings in Koorey's and the adjoining premises, and the construction of the buildings, of wood and closely adjoining one another, was such as to permit of a free intercommunication of rats in this block. At the back of these buildings is Webster's-lane, which has already been mentioned as furnishing plague-infected rats earlier in the year.

N.B.—The clinical course of this case appears to strongly attest the value of Yersin's serum. At the outset the clinical and bacteriological evidence indicated that the case would probably be severe, and, if not fatal, at least accompanied by extensive necrosis in the bubo. Two doses of serum, 60 c.c. and 80 c.c. were given, after which the temperature fell, never to rise again, and the bubo gradually resolved without suppuration.

Part III.

Plague in Rats.

The first positive proof of epizoötic plague in Ballina was furnished on 14th February, 1905, when 6 dead rats were found at Webster's stables, of which 4 were demonstrably plague-infected, and the other 2 were putrid.

Prior to this the case of Mrs. Esther Nicholls (Case A) had occurred, and in connection with it information had been obtained that on the premises occupied by her, dead rats had been noticed about the middle of January. No reliable report of any other dead rats or mice could be obtained. The relation of Nicholl's bakery to the water front occupied by the Brisbane steamer wharf has already been described.

I have also drawn attention to the fact that the only sewer in the town was one running down Cherry-street past Webster's stables to the water front, and that Webster's lane was in direct communication with this sewer by a drain, untrapped and insufficiently protected against the entrance of rats.

After the discovery of plague rats at Webster's stables on 14th February, vigorous cleansing operations were undertaken at this spot with the result that on the next day, 15th February, 15 other dead rats were obtained, of which 8 were demonstrably infected, and 7 putrid. In the following two days, 3 other putrid rats were found in a bootshop in the same buildings, and 1 plague-infected cat in the Salvation Army Barracks adjoining.

These findings indicated that here was the principal focus of the epizootic, but at the same period, on 15th and 16th February respectively, plague-infected rats were obtained from the North Coast Steam Navigation Company's Wharf, and from Tattersall's Hotel. The wharf in question is only a few hundred yards west of the Brisbane Wharf, but the hotel is quite three-quarters of a mile away from Webster's stables. It seemed probable that infected rats had been transported to the hotel in forage or other goods, rather than that they were the result of migration, as there was no evidence of the epizootic on any of the premises lying between the hotel and the parts of the town known to be infected.

Forthwith on my arrival in Ballina on 11th February, in connection with Case A, I had begun the bacteriological examination of rats obtainable in the town. The Council engaged an experienced rat-catcher who brought his catch each morning for examination, and all citizens were exhorted to do the same with any dead rats or mice they might obtain. In this way 403 rats and mice were examined between 11th and 24th February; but in the last week of this period, not only were no plague-infected rats obtained, but rats of any kind had become so scarce that the rat-catcher's nightly takings, with 50 to 60 traps, amounted to only 3 or 4. This diminution in rats was probably due in part to the mortality and the scare caused by the epizootic, but also to the wholesale use of poison baits (phosphorus). On 16th February there was made a house to house distribution of these poison baits to all premises in the municipality, and this was followed by a marked diminution of the rat population, though not many poisoned rats were obtained. On 24th February, as the result of examination had been negative for a week, and, as it was desirable that I should return to the Clarence River (Ulmarra), my examination of Ballina rats came to an end.

Of the 403 rats and mice which were examined in this period, February 11th–24th, 16 were plague infected as demonstrated morphologically by smear preparations, and in most cases by culture also; 13 other rats found dead were too putrid for satisfactory examination.

The infected cat was brought to me as being sick, and was killed for the purpose of examination. It presented the lesions which appear to be common in plague-infected cats, namely, symmetrical submaxillary buboes which yielded pure cultures of *B. pestis*.

After February 17th there ensued an interval of six weeks until the finding of the next plague-infected rat on March 31st.

It is possible that dead rats were found during this interval and the finding concealed from the authorities, but it is certain that if there had been any considerable number the fact would have been divulged. Some suspicion attached to the circumstance that about March 27th, 2 dead rats were found in Webster's Hotel, but these rats are said to have been burnt by an ignorant employee, and were not examined.

On 31st March a plague infected rat was found dead at Dr. Corlis' stables, and on 5th April another in the same place. Smears from these rats were obtained by Dr. Corlis and by a laboratory assistant from this Department with considerable experience in this subject, who were agreed as to the infection. These stables are at the back of Dr. Corlis' residence in Crane-street, in a sparsely-occupied block to which no suspicion had hitherto attached, and which is well removed from any of the previously infected premises. Like most of the buildings in the town, this residence and the stables are of wood, but on examination by a Sanitary Inspector of this Department were found to show very slight signs of rat infestation; nor were the neighbouring premises rat infested. Forage for three or four horses had been obtained from a produce store in River-street, but a search of this store did not yield any results. One rat trapped in this produce store on 3rd April was uninfected.

A general reinspection of the business premises of the town was made at this time by the Sanitary Inspector above mentioned, who found them "fairly free of signs of rat infestation." Between 7th and 14th April, 30 rats were trapped and examined but all were found uninfected.

The next manifestation of the epizootic was at Kempnich's farm, 5 miles from Ballina, along the Bangalow-road. Here occurred Case B (John Day), and investigation occasioned by his illness resulted in the finding on 27th April to 1st May of 2 dead rats and 3 dead mice in which plague infection was demonstrated, and of 14 rats and 20 mice which were too decomposed for bacteriological examination. It was learned, also, that about two weeks before this 3 dead rats had been found.

On 2nd May there occurred Case C (Elizabeth Wallbridge), but no other infected rats were obtained until on 17th May 4 dead rats and on 19th May 1 other were found at Martin and Williamson's produce store in River-street. All these 5 rats proved on examination to be plague infected. These premises were used as auction rooms for the sale of produce and general merchandise. They were clean and well kept, but of wood, and open to the inroads of rats, whose track was traced from the adjoining premises under the tar-paved footpath. In the premises immediately adjoining, Case D (Mary Koorey) was attacked on 28th May.

Since 19th May no more plague infected rats have been heard of in Ballina, nor has there been any report of rat mortality.

Thus the epizöotic manifestations extended over the period 14th February to 19th May, 1905. This persistence, in spite of vigorous cleansing operations, may be attributed partly, I think, to the condition of the foreshore which, being faced with rough stones, provided ample shelter from which it was impracticable to entirely dislodge the rats, and partly to the fact of the houses being built of wood, with, of course, linings and double partitions, which greatly added to the difficulties of rat extermination.

Whence the plague rats were introduced to Ballina can only be conjectured, but it is at least very suggestive that the first case occurred on premises closely related to the wharf used by the Brisbane trader, the ss. "Pyrmont," and that Webster's stables, which appeared to be the important focus of the epizootic, were connected by an untrapped sewer with the foreshore near the same wharf.

The following table shows the place at which, and the first and last dates on which plague-infected rodents and a plague-infected cat were taken in Ballina and neighbourhood; the entries are numbered consecutively in accordance with the dates on which they were first taken. References to the four cases which occurred here are inserted in the series in their order according to their attack :—

No.	Place.	Infected Rodents Taken.				
		Total.	Rats.	Mice.	First.	Last.
	Case A, attacked 3/2/05—					
1	Webster's stables and Shop, Cherry-street	12	12	...	14/2/05	15/2/05
2	N.C.S.N. Co.'s Wharf...	1	1	...	15/2/05	......
3	Ainsworth's, Webster's-lane	1	1	...	16/2/05	......
4	Tattersall's Hotel	1	1	...	16/2/05	......
5	Salvation Army Barracks, Cherry-street	1 cat	...	...	17/2/05	......
6	Notley's store, River-street	1	1	...	17/2/05	......
7	Dr. Corlis' stables	2	2	...	31/3/05	5/4/05
	Case B, attacked 22/4/05—					
8	Kempnich's farm	5	2	3	27/4/05	1/5/05
	Case C, attacked 2/5/05—					
9	Martin and Williamson's store, River-street ...	5	5	...	17/5/05	19/5/05
	Case D, attacked 28/5/05.					

PART IV.

ADMINISTRATIVE MEASURES.

The preventive measures adopted consisted of destruction of rats and cleansing of premises by the removal from back yards and from under houses of rubbish likely to harbour rats. This latter work was begun on 14th February, and was carried on by two gangs of men paid by this Department, and under the immediate supervision of a sanitary inspector of the Department.

At the same time, a rat-catcher employed by the Council set traps throughout the town, and each morning brought his catch to me for examination. From any rat presenting naked-eye appearances suggestive of plague, smears were made, stained, and microscopically examined forthwith, and, if necessary, agar cultures were made. Smears and cultures from plague-infected animals were subsequently forwarded to the Departmental Laboratory for confirmation of my diagnosis.

On 16th February the council, on my advice, made an organised house to house distribution of phosphorus baits, together with a handbill explaining how to use them. Altogether over 3,000 baits were distributed, in bags containing 6 each. At the same time, the Departmental pamphlet on plague prevention was distributed to all households.

The systematic cleansing operations were brought to a close on 25th February. When the later cases occurred, the local authority worked on the same lines.

As already stated, the patients were all removed to the Ballina Hospital for treatment. A separate ward was used, and nurses with previous experience of the disease were sent to Ballina by the Department. These nurses were not isolated from the rest of the staff.

B. SOUTH WOODBURN.

THE EPIZOÖTIC AT SOUTH WOODBURN.

South Woodburn is an unincorporated village of some 80 houses on the south bank of the Richmond River, about 40 miles by water above Ballina. It contains two hotels and several stores, and is a centre for the surrounding dairying district. It is a place of call for the ocean steamers as they pass up and down the river, is also in daily communication with Ballina and other smaller places below, and with Lismore, Coraki, and other places on the river above it, by small steamers which carry passengers and goods. Coaches conveying mails and passengers run frequently from South Woodburn to Chatsworth on the Clarence River.

The first intimation of the existence of plague-infected rats here was received from Mr. Veterinary Inspector McEachran, M.R.C.V.S., of this Department, who, in the course of his duty, was for the time being residing at South Woodburn. He reported on 18th March, 1905, that a dead and a sick rat had been found at Murray's Hotel, South Woodburn; that he had made post-mortem examinations, and found lesions suggestive of plague infection, and that he was forwarding specimens for examination in the Department's Laboratory. Two days later, on 20th March, another dead rat was found on the roof of the hotel, and specimens from this also were forwarded by Mr. McEachran. Cultural and inoculation tests in the Department's Laboratory showed that all three rats were plague-infected.

Accordingly, an experienced sanitary inspector, a laboratory assistant, and two rat-catchers were despatched by the Department from Sydney, and arrived at South Woodburn on 30th March.

Cleansing operations and the catching and examination of rats were at once instituted, and continued until 16th April. During this period 83 premises in South Woodburn, and 39 in the opposite village of North Woodburn, were dealt with, and examination was made of 249 rats and 80 mice.

Plague-infected rats were found on two premises only, namely, the two hotels. These are alike in construction, built of wood, and each containing 32 rooms, and stand on adjoining allotments in the main street, about 100 yards from the wharf. At Murray's Hotel, infected rats were obtained, as already stated, on March 18th and 20th, and during cleansing operations other 2 were found dead and putrid. At Priddle's Hotel, during cleansing operations on 1st April, 4 rats were found dead and putrid, and on 9th April, 2 other dead rats were found in an outhouse, one of which proved on examination to be plague-infected. On three other premises dead rats, 4, 1, and 2, respectively were found, but they were putrid and the cause of death could not be determined.

No information was obtainable of any previous mortality among the rats, but it was stated locally that about the middle of February the rats had suddenly disappeared from the wharf, which previously had been infested with them. Of the rats examined, a very large proportion, about 83 per cent. were found to be of the species *M. Rattus*, and the rest *M. Decumanus*; and it was observed that burrows indicating infestation by the latter species were comparatively rare.

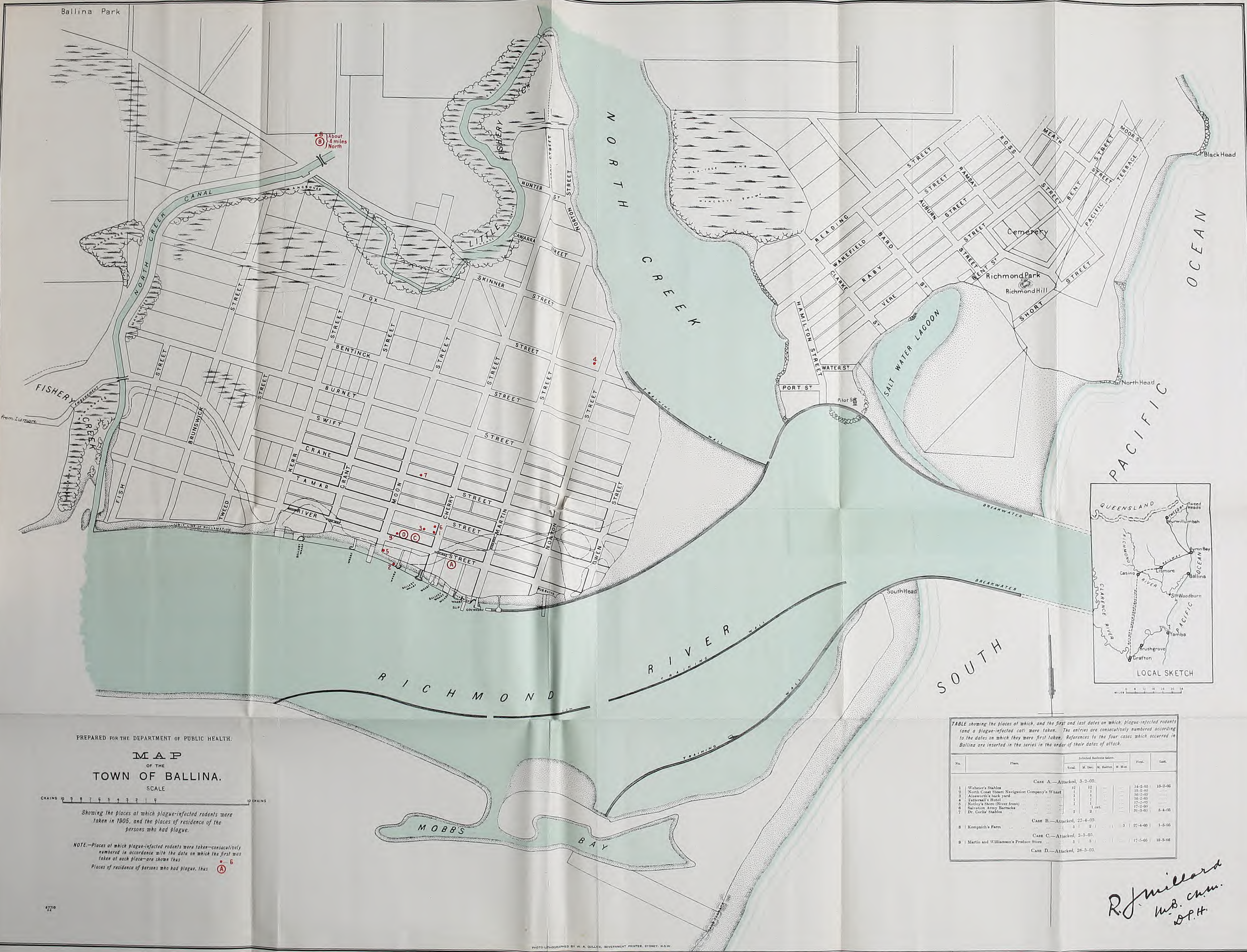
On completion of the work already described, the staff returned to Sydney on April 18th.

No further indications of the epizootic were manifested until some six weeks later, when Mr. Davis, residing about half a mile from South Woodburn, found a dead rat under his dwelling on 28th May, and another on 29th May. The second rat was forwarded by the Police to Ballina, and on examination I found it to be plague-infected. Mr. Davis was instructed as to clearing his premises of rats, and no further mortality was reported.

The sequence of events at Woodburn, as far as can be conjectured from the meagre data available, was apparently that plague-infected rats were landed at the wharf by steamer, either from Ballina, or by an ocean steamer from Brisbane or Sydney. It should be noted that the daily river steamer from Ballina reaches South Woodburn in the afternoon, and lies at the wharf till next morning—a circumstance which would considerably facilitate the landing of rats. From the wharf the rats appear to have made their way to the two largest, and to them the most attractive, premises—the hotels. Thence, possibly as the result of the vigorous cleansing operations, they migrated, and their appearance half a mile away, at Mr. Davis', 6 weeks later, was probably the result of this migration. It is, however, possible that this later manifestation was the result of re-introduction of infected rats to Woodburn, as at that date (May 28th) there was epizootic plague at both Ballina and Lismore.

No cases occurred amongst human beings.

C.


Ballina Park
NORTH CREEK CANAL
LITTLE FISHERY CK
FISHERY CREEK
From Lismore
8 (B) About 4 miles North
FOX, BENTINCK, BURNET, SWIFT, CRANE, TAMAR, RIVER, CHERRY, SKINNER, CAWARRA, HUNTER ST, NORTON STREET
KERR, GRANT, MOON, MARTIN, TWEED, FISH, BRUNSWICK, OWEN
NORTH CREEK
TRAINING WALL
BREAKWATER
SALT WATER LAGOON
READING, WAKEFIELD, BARD, CLARKE, RABY, VERE ST, HAMILTON STREET, WATER ST, PORT ST, AUBURN STREET, RAMSAY, ROSS, MEATH, MOORS, BENT ST, PACIFIC TERRACE, SHORT STREET
Cemetery
Richmond Park
Richmond Hill
Pilot St
Black Head
North Head
South Head
PACIFIC OCEAN
RICHMOND RIVER
SOUTH
MOBBS BAY
1, 2, 3, 4, 5, 6, 7, 9, (A), (C), (D)
QUEENSLAND, Tweed Heads, Murwillumbah, Byron Bay, Lismore, Casino, Ballina, Sth Woodburn, Tamba, Brushgrove, Grafton, RICHMOND RIVER, CLARENCE RIVER, PACIFIC OCEAN
LOCAL SKETCH
MILES 0 6 12 18 24 30 34

PREPARED FOR THE DEPARTMENT OF PUBLIC HEALTH.

MAP
OF THE
TOWN OF BALLINA.

SCALE

CHAINS 10 9 8 7 6 5 4 3 2 1 0 10 CHAINS

Showing the places at which plague-infected rodents were taken in 1905, and the places of residence of the persons who had plague.

NOTE.—Places at which plague-infected rodents were taken—consecutively numbered in accordance with the date on which the first was taken at each place—are shown thus ● 6

Places of residence of persons who had plague, thus Ⓐ

67710
94

TABLE showing the places at which, and the first and last dates on which, plague-infected rodents (and a plague-infected cat) were taken. The entries are consecutively numbered according to the dates on which they were first taken. References to the four cases which occurred in Ballina are inserted in the series in the order of their dates of attack.

No.	Place.	Infected Rodents taken.				First.	Last.
		Total.	M. Dec.	M. Rattus	M. Mus.		
	Case A.—Attacked, 3-2-05.						
1	Webster's Stables	12	12	...	...	14-2-05	15-2-05
2	North Coast Steam Navigation Company's Wharf	1	1	...	...	15-2-05	......
3	Ainsworth's back yard	1	1	...	...	16-2-05	......
4	Tattersall's Hotel	1	1	...	...	16-2-05	......
5	Notley's Store (River front)	1	1	...	...	17-2-05	......
6	Salvation Army Barracks	...	1 cat.		...	17-2-05	......
7	Dr. Corlis' Stables	2	2	...	...	31-3-05	5-4-05
	Case B.—Attacked, 22-4-05.						
8	Kempnich's Farm	5	2	...	3	27-4-05	1-5-05
	Case C.—Attacked, 2-5-05.						
9	Martin and Williamson's Produce Store	5	5	...	...	17-5-05	19-5-05
	Case D.—Attacked, 28-5-05.						

R. J. Millard
M.B. Ch.M.
D.P.H.

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Seamen's Hospital Society
TROPICAL DISEASES
19 JUN. 1923
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C. LISMORE.

PART I.

GENERAL DESCRIPTION OF LISMORE.

Lismore is situated on the north arm of the Richmond River, at the head of navigation, and is distant from Ballina about 21 miles by land and 62 by river, being thus 22 miles above Woodburn. The population at the last census, in 1901, was 4,378, and the dwellings inhabited 773, uninhabited 52. Owing to the lack of clay suitable for brickmaking, the buildings are almost universally of wood, 779 being so described at the census.

The area of the municipality is 14,061 acres, but a large portion of this is rural in character, and the business premises and many of the residences are concentrated in a few blocks on the flat land adjoining the river bank. This congested business area has as its northern boundary a watercourse known as Brown's Creek, which joins the river a short distance above the wharf principally used by the ocean-going steamers.

The town has lately been sewered, and the house connections were being made at the time of this plague outbreak. Previously there were no sewers, and, for the conveyance of slop and surface waters, recourse was had to some badly-constructed and dilapidated box drains, of which the principal one still exists, and leads from the centre of the main business block, under Woodlark-street, to discharge on the bank of Brown's Creek.

There are no cesspits in the town. Pail closets are in general use.

The regular removal of house refuse, rubbish, and garbage has not been enforced by the Council, and in consequence most premises were found encumbered with accumulations of these matters. This was especially the case on the premises backing on Brown's Creek, which appears to have been regarded as a legitimate tip.

Products, Communications, &c.—Lismore is the centre of a rich and important district, in which dairy-farming and sugar-growing are the chief industries. Butter is the principal article of export, but the imports include general merchandise of every description.

There is railway communication with Murwillumbah, on the Tweed River (61 miles), and with Casino (18 miles); but by far the greater part of the trade is carried by water. Every week two steamers from Sydney and one from Brisbane come regularly to Lismore, which is their terminal port after they have called at Ballina, Woodburn, Coraki, and other places on the river below Lismore. These steamers generally remain at Lismore two or three nights while they unload and reload for the return voyage. Other occasional ocean boats come with special cargoes, as of coal from Newcastle. Besides these there are several regular river steamers plying regularly between Lismore and Woodburn, and calling at all wharves to collect or put off passengers and freight. The freight is mainly cream for the butter factories, but includes general stores also.

PART II.

PLAGUE IN MAN.

The first recognised case of Plague at Lismore was that of George Elliott, aged 26 years, an assistant draper in McDermott's general store. He was attacked on the afternoon of the 1st May, and died five days later.

It is not, however, certain that this was the first case that occurred. Three deaths, one in March, and two in April, had been certified as due to dengue fever. This disease is seldom fatal, and in discussing these cases with their medical attendants, I learned that their symptoms were not typical of dengue, and that in the light of subsequent occurrences, plague could not be absolutely excluded.

At the same time, however, there was widespread epidemic of dengue in Brisbane, and several other cases are said to have occurred in Lismore. As regards the fatal cases above mentioned, it was stated that there was enlargement of glands, but in none was a bubo a sufficiently prominent feature to arrest attention and suggest at the time the diagnosis of plague.

Another case to which my attention was called by the medical attendant was that of Miss G. S., aged 25 years, domestic duties, whose history was that, on 26th April, 1905, she was taken ill with severe pain in the right axilla, pyrexia, and severe headache. She remained in bed, and on 29th April sent for her doctor, who found temperature 102 degrees, and a tender axillary swelling. Her symptoms soon abated, however, and after seven or eight days in bed she was able to resume her household occupations, feeling somewhat weak, but otherwise unaffected. The axillary swelling was slow in disappearing, and when seen by me, on 16th May, she had a deeply-seated axillary bubo rather smaller than a walnut, and not tender. On puncture some clear fluid was obtained, but nothing grew from this when sown on an agar. This may have been a mild case of plague, but it is more usual for an axillary plague to be accompanied with severe symptoms. This patient has not been away from Lismore for many weeks.

The facts concerning the eight cases reported and diagnosed as plague are as follow:—

CASE A.—ELLIOTT, GEORGE.

Summary.—Male, æt. 26 years, unmarried, draper's assistant. No former attack; not inoculated; no known communication with any previous case. Residence, Kean-street, Lismore, about half a mile north of his place of employment, which was at McDermott's general store, Woodlark-street; had not been away from Lismore for many weeks prior to attack. Attacked 1st May; died 6th May; bubo, left femoral; morphological tests positive.

History of illness.—1st May—After being at work as usual all day in his usual health, he was at 5 p.m. suddenly attacked with shivering and vomiting, and developed severe headache. 2nd May—Seen by his medical attendant, and sent to a private hospital during the morning; temperature then, 105°. 3rd and 4th May—Very ill, semi-delirious; plague being suspected, bubo was sought for, but without success. 5th May—In the morning his medical attendant found definite left femoral bubo "as large as a pigeon's egg," and extremely tender. In the afternoon of the same day he was seen in consultation with Dr. Corlis, of Ballina, who made smears from fluid obtained by puncture of the bubo; these smears contained numerous bacilli morphologically identical with *B. pestis.* 6th May—After a somewhat restless night, he died very suddenly about 7 a.m.

Residence.—A wooden cottage, clean, and in fairly good repair.

Employment.—A large general store in Woodlark-street, built of weatherboard and galvanized iron. In the main store was a large stock of general goods, and at the back, in another building, bulk goods and farm produce were stored. Between these was a lane giving access to the backs of the shops, &c., in the block, and from this lane a box drain ran under Woodlark-street to discharge on the bank of Brown's Creek. This box drain had several inlets in and about the lane, most of them being by gulleys of defective character.

Rats.—At residence, few or none. None obtainable for examination. At place of employment, on 22nd April, 19 dead rats had been found in the ironmongery department, and on 25th April—when the shop was opened after the Easter holidays, 2 or 3 more, one of these last being behind a roll of calico in the drapery department, where this patient worked. Poison had been laid in February and March but not since. The store was thoroughly turned out on 9th to 11th May by a cleansing gang under two experienced foremen despatched by the Department. No other dead rats were found.

CASE B.—TONKIN, AMY JANE.

Summary.—Wife of dairyman, æt. 35 years. No previous attack; not inoculated; no communication with any previous case. Resided on her husband's dairy farm about 3 miles out of Lismore. Comes to town frequently. Prior to her illness was last in town on 28th April, when she visited McDermott's general store (*vide* Case A) amongst other places. Remained in town from noon till 2·30 p.m. Did not stable her horse, but tied up in the street. Attacked, 1st May; to hospital, 7th May; discharged, 22nd May. Bubo, right inguinal.

History of Illness.—1st May—Felt out of sorts in afternoon, and could hardly do her milking; was heavy and weak with headache. 2nd May—Worse; milked 4 cows in the morning, then had to cease work; had an attack of shivering. 3rd May—Observed a lump in right groin, which was very tender, 4th May—Feeling very bad, but dragging herself about. 7th May—Consulted her medical attendant, who found temperature 102·4°; tongue brown. Sent to hospital, where she was collapsed with sub-normal temperature. 10th May—When seen by me her temperature and pulse were normal, but there was still a right inguinal bubo about the size of a pigeon's egg, not very tender on palpation. Fluid obtained by puncture of this bubo showed no bacilli in smear, nor did it produce any growth when sown on agar. The subsequent course of the case was uneventful. The bubo grew gradually smaller, and she was discharged from hospital convalescent on 22nd May.

Residence.—A four-roomed cottage, 3 miles out of Lismore, built on a slope, and with the front resting on piles. No indication of infestation by rats, and no history of any dead or sick rats about the house or the dairy farm. No produce nor other goods likely to carry rats had been obtained from town.

Rats.—As above stated, patient had been shopping at McDermott's store in Lismore on 28th April, and had been looking at goods in the drapery department, where at least 1 dead rat had been found on 25th April, and where Elliott (Case A) was working when taken ill on 1st May.

N.B.—Cases A and B were attacked on the same day (1st May) and both in the afternoon.

CASE C.—SKIDMORE, EPHRAIM FRANCIS.

Summary.—Married, æt. 41 years. In charge of ironmongery department at McDermott's store. No previous attack; not inoculated. Had worked in same store as Case A, and had possibly served Case B on 28th April, but had had no communication with either case subsequent to 1st May, when they were attacked. Attacked, 3rd May; to hospital, 7th May; discharged, 23rd May. Bubo, left femoral. Resided in Keen-street, about half a mile south of place of employment.

Movements prior to Attack.—Had not been away from Lismore for many weeks, but had been every day employed at McDermott's store.

History of Illness.—3rd May—After working as usual in the morning, going out for his Wednesday half-holiday, and eating a good tea, he was suddenly attacked about 8 p.m. Had rigor and vomiting, which lasted half an hour, and severe headache all night. Did not sleep. 4th May—Seen by his medical attendant about noon. Temperature, 103·8°; tongue coated; pains in back; and severe headache. At night had some pain in upper and inner part of left thigh as if he had strained the muscles. Had a restless night. 5th May—About the same. 6th May—Inflamed gland (left femoral) now observed; temperature, 102·6°; headache still. 7th May—Admitted to hospital; temperature, 101°; pulse, 84. 10th May—First seen by me; temperature was now normal, but there was a left femoral bubo about the size of a walnut, and also an enlarged deep inguinal gland on the same side; both could be palpated without causing much pain; fluid obtained on this date by puncture of bubo was examined for bacilli by smear and culture, but with negative result; his subsequent course was uneventful; the temperature remained normal, except for one slight rise due to another cause than plague; the enlarged glands remained indolent. 23rd May—Discharged convalescent to his own home, when the bubo eventually suppurated.

Residence.—A wooden cottage, clean and well kept.

Employment.—*Vide* under Case A.

Rats.—*Vide* Case A. The first search, which discovered 19 dead rats on 22nd April, was made by this patient in consequence of bad smells in his department of the shop.

CASE D.—MULLINS, JAMES.

Summary.—Æt. 22 years. Employed in McDermott's store as assistant to Skidmore (Case C) in the ironmongery department; resided in lodgings in Little Keen street, about half a mile away. No previous attack; not inoculated; fell ill six days after Elliott (Case A), and four days after Skidmore (Case C), both fellow employees, but probably had no communication with either of these patients after they became ill. Attacked, 7th May; to hospital, 12th May; died 16th May; duration of illness, nine days; no bubo; plague pneumonia or pneumonic plague; morphological and cultural tests positive.

Movements before Attack.—Had not been away from Lismore for many weeks. Employed all day in the store.

History of Illness.—7th May (Sunday)—On waking had headache and pains all over him. 8th May—Unable to go to work, but did not keep to his bed. 12th May—As he did not improve, he called in his medical attendant, who sent him to the hospital to a private ward. By request of his medical attendant, I saw him soon after admission. His temperature then was 102·6°, and his tongue inclined to be dry. His only complaint was of general pains all over; no indication of any bubo could be found anywhere. The abdomen was somewhat full, and there was some tenderness on deep pressure of the right iliac fossa, also the spleen was enlarged. 13th May—Temperature ranged between 101° and 102·8° for a good part of the day. He was semi-delirious, talking nonsense, but remembering afterwards what he had said and done. At night he complained of severe pain in the back. 14th May—Temperature, 103° at 4 a.m., fell to 100° at 4 p.m.; pulse about 112; respiration in evening, 44; no cough; no sputum, and, on examination by his medical attendant, no physical sign of pneumonia; still delirious at night, complaining greatly of pain, but unable to locate it, except sometimes in the small of the back. 15th May—Temperature, 4 a.m., 102°; 8 a.m., 99·2°; 12 (noon), 102·6°; 4 p.m., 104°; pulse and respiration at 4 p.m., 134 and 48; his medical attendant prescribed baths, and he had three, at 4 p.m., at midnight, and 4 a.m.; in spite of these, the temperature remained up at nearly 104°; death took place at 9·40 a.m. on 16th May; *post mortem* examination 2·30 p.m.; lividity of dependent parts well marked; no bubo or external swelling.

Chest.—Pericardium contained a large quantity of fluid; no pericarditis; no subserous hæmorrhages; heart fairly normal.

Lungs.—Both showed scattered dark hæmorrhagic patches, which were solidified to touch; the posterior parts of both showed livid consolidation; the condition amounted to a scattered lobular pneumonia.

Abdomen.—The liver, spleen, and kidneys were all enlarged, but specially the liver, which was besides abnormally yellow. The intestines showed some general congestion of the vessels, and this appeared in places to be accentuated in the region of a Peyer's patch; the mesenteric glands were normal in size and appearance; the inguinal glands were quite discrete, but appeared slightly larger than normal, so were removed for examination. Smears were made direct from spleen, liver, and right lung (a hæmorrhagic patch), and cultures from spleen, liver, right kidney, right lung, and heart blood. The following were removed and preserved in spirit:—Inguinal glands (right and left), portions of spleen, liver, right kidney, a Peyer's patch, and a portion of right lung. Immediate examination of smears gave the following result:—Lung — Masses of bacilli morphologically same as *Pestis*, decolourised by Gram's method. Cultures gave the following result:—

Right kidney	No growth.
Spleen	Positive for *Pestis*.
Liver	No growth.
Heart's blood	No growth.
Right lung	Original culture, mixed growths; sub-culture, positive for *Pestis*.

Residence.—A wooden cottage, cleanly kept, and in good repair.

Employment.—McDermott's store (*vide supra*).

Rats (*vide supra*).—Nineteen dead rats were found in the store on 22nd April, and more on 25th April, and during the cleansing operations other dead rats were found at the rear of the store on 9th and 10th May. From this it appears that the mortality among rats in the immediate neighbourhood of the store continued over the probable date of infection of this patient.

CASE E.—CONNELL, DANIEL.

Summary.—Æt. about 65 years; did odd jobs, as watchmaker, umbrella-mender, &c. No previous attack; not inoculated; no known communication with any previous case. Resided at McCormack's Hotel, North Lismore. Attacked, 7th May; died, 9th May; duration of illness, thirty hours; bubo, right femoral.

Movements prior to Attack.—He had not been away from Lismore; but in looking for work he probably frequented various parts of the town.

History of Illness.—He is said to have been intemperate, and not robust, but was apparently in his usual health until the evening of 7th May. 7th May—On this evening the stableman at the hotel heard him call out, and on going to his assistance found him lying on the ground "as if he had had a fit"; he helped him back to his room, Connell being unable to walk; the old man complained of no definite symptoms, but seemingly was in a state of collapse. 8th May—Taken in a cab to the Lismore Hospital, and admitted about 11 a.m.; on admission he was delirious, and could give no account of himself; he appeared to have severe pain in right lower limb; had a femoral bubo, and also some swelling at right knee—possibly a popliteal bubo; the tongue showed furred edges, and a dry, cracked central strip; pulse was very bad; body surface was generally mottled, and also showed numerous petechiæ, small at first, but later of larger size. 9th May—He never rallied, but died about 2 a.m., the total duration of illness having been about thirty hours from the onset of symptons to the fatal termination.

Residence.—The room which he occupied at the hotel was part of the stables, had an earthen floor, and communicated with the stalls. The furniture was of the poorest description, and the room contained much filthy rubbish. These stables are about 30 yards from the hotel. The hotel is a weatherboard two-storied building, on a site which falls away from the street front. Under the ground floor, and opening towards the stable, are feed-room, groom's room, wash-house, and unoccupied space. The hotel stands on a point of land between two arms of the river, and close to the river bank, and to the bridge which crosses from this point to the centre of the main town (South Lismore).

Rats.—The licensee said he had at times found dead rats about the place, the last having been found in the wash-house about the time that Connell was attacked. These rats were destroyed as found, without any examination, but had probably died of disease, as no poison had recently been laid. The structure of the house is such as to afford shelter to rats, and its position, close to the river-bank, makes it a likely resort. During cleansing operations in the town, traps were repeatedly set here, but without result. Any rats that had previously infested the place had, for some reason or other, scattered elsewhere.

CASE F.—ANDERSON, CECIL.

Summary.—Schoolboy, æt. 12 years. No previous attack; not inoculated; no communication with any other case. Residing with parents at Orion-street. Attacked on 9th May; notified on 10th May, at 2 p.m., and visited by me at once; removed to Lismore Hospital same day, at 3·30 p.m.; discharged 31st May; duration of illness, 22 days; right femoral bubo; bacteriological examination negative.

Movements before Attack.—Had not been away from Lismore for many weeks. On 8th May, in morning and afternoon, had been watching cleansing operations behind McDermott's store. (*Vide* Cases A, B, C.)

History of Illness.—9th May—About 6 p.m, complained of a painful lump in right groin; but, later, played about in the street. 10th May—Woke with severe headache, was dizzy and unable to stand; seen by his medical attendant at 10·30 a.m., when he had temperature 103°, and definite bubo in right groin. When seen by me at 2·45 p.m., had temperature 105°; pulse, 150; large very tender swelling in right Scarpa's triangle, and some tenderness above Poupart's ligament; lips were dry, tongue coated but moist; was drowsy and unable to give account of himself; on admission to hospital temperature was still 105°, and the same at midnight, when he had a rigor. 11th May—Better; temperature, 104° at 4 a.m., 100·4° at midnight. 12th May—Had a good night, and this morning temperature normal; still somewhat drowsy, and there is some painful enlargement of a left cervical gland. 13th May—Better; tongue cleaning, and temperature keeping down; swelling of neck subsided with use of fomentations; femoral bubo still large and tender; subsequent course was uncomplicated; the bubo suppurated, and was opened on 23rd May. 31st May—Discharged cured.

Residence.—A wooden cottage of rather poor description, but clean, and showing no sign of rat infestation.

Rats.—None at residence, but many dead rats had been found in and about McDermott's store, in the vicinity of which he was for several hours on the day before his attack.

CASE G.—DUFFY, FRANCIS.

Summary—Æt. 25 years; foreman employed in cleansing gang. No previous attack; not inoculated; no communication with any previous case. Attacked on 11th May; reported sick on 12th May, 7 a.m.; removed to hospital at once same day; discharged 31st May; duration of illness, 19 days; right inguinal bubo; morphological and cultural tests positive.

Movements before Attack.—Left Sydney by steamer on 6th May, and arrived at Lismore on the afternoon of 8th May. Began work of cleansing McDermott's store on 9th May. Finished this work on the 10th, and worked in block at back of store on 11th May.

History of Illness.—11th May—About noon, while at work, noticed that a right inguinal gland was somewhat enlarged and slightly tender ; finished his day's work, and at night was restless, talking in his sleep. 12th May—In morning felt weak, had pains in both legs and back, and an acutely tender right inguinal gland about the size of a marble ; admitted to hospital at 8 a.m. ; temperature at 8 a.m., subnormal ; at 8 p.m., 102·8° ; at 2·30 p.m. on same day had 60 c.c. Yersin serum hypodermically. 13th May—Had a good night ; temperature, 8 a.m., 102·6° ; 8 p.m., 100·5° ; bubo very tender, but no larger. 14th May—Temperature, 8 a.m., 99·2° ; 8 p.m., 98·2°. 15th and 16th May—Temperature normal. 19th May—Slight urticaria began to show itself round the point of serum injection (performed on 12th May) ; following this urticaria there ensued severe joint pains, affecting especially elbows, right thumb, ankles, and toes ; at the same time the temperature gradually rose, and on 23rd was 102° at 8 a.m. ; at the same time the bubo was gradually diminishing ; after the 23rd the pains subsided, and a week later he was able to be on the verandah on a couch. 31st May—He was discharged convalescent. N.B.—This case presents several important points of interest : *The incubation period* of the disease was apparently under three days, as patient did not reach Lismore till the afternoon of the 8th, and felt the first symptoms at about noon on the 11th ; *the mildness of the case*, though associated with an undoubted infection with the *B. pestis* ; *the two effects of serum injection* ; the rapid improvement in symptoms, followed seven days after the injection by urticaria, severe joint pains, and pyrexia.

Residence.—At the time of attack he was lodging at an hotel in Molesworth street, which was clea and not under suspicion as infected, either then or subsequently.

Employment.—*Vide supra.*

Rats.—At residence, none. During cleansing operations at back of McDermott's store, several dea rats were found on 9th, but as I had not then arrived in Lismore, they were destroyed without examinatio

CASE II.—STAPLEFORD, PETER.

Summary.—Æt 22 years, single ; store assistant ; resides in Keen-street (between James and Park Streets), about half a mile from his place of employment, which was at Robertson's "Red Flag" store Molesworth-street. No former attack ; not inoculated ; no communication with any previous case Attacked 30th May. Notified by his medical attendant on same day at 1 p.m., and visited by me at once Removed to hospital on 31st May ; discharged on 22nd June ; duration of illness, 24 days. Bubo left femoral ; morphological and cultural tests of fluid from bubo and from vesicle on leg, both positive.

Movements before attack.—Had not been away from Lismore for many weeks. Occupied in the store all day ; at home in the evening.

History of Illness.—Up to 30th May was in his ordinary health. On this morning he noticed when dressing that he had some pain in upper and inner part of left thigh. Went to work as usual, but about 9 a.m. began to shiver and feel ill, and about 10 a.m. ceased work and went to see his medical attendant, who found temperature 101·4°, and a slightly enlarged and tender femoral gland. By the doctor's instructions he went home and to bed. Seen by me at 1·30 p.m. He had temperature of 103·2°, pulse, 126. Tongue moist and clean. A left femoral gland was enlarged to about the size of a small almond, but not markedly tender. Leading to the gland was a faint track of lymphangitis, which started from a small semi-pustular vesicle on the outer side of the upper third of the leg. This line of lymphangitis crossed below the knee-cap and ran up the inner side of the knee. Patient stated that he had noticed this first when he was going to bed after seeing his medical attendant, his attention being drawn to it by pain on the inner side of the knee. Smears made from the fluid in the vesicle showed scanty bacilli resembling *B. pestis*, and cultures from the same fluid subsequently established their identity. Yersin's serum 60 c.c. was at once injected at about 2 p.m. 31st May—Temperature, 105° at 12·15 p.m. ; he is drowsy but not in pain, and pulse fairly good ; three or four femoral glands could now be felt, enlarged to about the size of small almond and tender ; the lymphangitis no longer seen ; Yersin's serum repeated, 60 c.c. at 1 p.m. ; removed to Lismore Hospital during the afternoon ; at 8 p.m. temperature 106·4°, pulse, 90 ; Yersin's serum, 60 c.c. at 8·45 p.m. 1st June—Temperature ranged from 105° at noon to 103·6° at midnight. Pulse never more than 100, but soft. Semi-delirious at times. Vomited occasionally. Bubo now characteristic, the formerly discrete enlarged glands having become matted together. Fluid from this bubo showed innumerable *B. pestis* in smear and gave a pure culture of *B. pestis* when sown on Agar. Yersin's serum, 60 c.c. at 3·30 p.m. and at 9·30 p.m. Nuclein hypodermically—10 a.m. ʒ i, 3 p.m. ʒ i, 6 p.m. and 8 p.m. M. 15. 2nd June—Temperature at 6 a.m. had fallen to 102°, but during the morning it rose, and at 2 p.m. reached 104°, at which level it stayed till 10 p.m. Pulse not above 90. Bubo not increasing in size and not so tender as before. Yersin's serum 60 c.c. at 5·30 p.m. Nuclein 6 a.m. M. 30, 2 p.m. M.15, 10 p.m. M.15. 3rd June—Temperature between 103° and 104° from 6 a.m. till 4 p.m., but after that fell steadily. Pulse good. 4th June—Temperature never rose above 100°. The vesicle on left leg became a pustule, and ultimately a small slough formed which has now separated, leaving a round "punched out" sore. There is to-day a revival of the red blush along the path of the former lymphangitis, and in the thigh a cord of lymphatics can be indistinctly felt. 5th June—Temperature normal all day. In the early morning the pulse fell to 54, and temperature to 97·40°. Bubo now gives no pain, is smaller and more defined. 9th June—Evening temperature for past three days has been 100° or over, and at 6 p.m. to-night is 102° ; probably due to suppuration in bubo. 15th June—Evening rise and morning remission have continued. Temperature this evening 103°. Bubo freely incised. 23rd June—Temperature fell after opening of bubo, and convalescence progressed uninterruptedly. Discharged from hospital to-day.

Residence.—A good class wooden cottage, clean, and in good repair.

Employment.—Patient was employed in the ironmongery department of Robertson's "Red Flag" store, Molesworth-street. The building is a large general store, constructed of wood and iron, containing a heavy stock of goods, including groceries, ironmongery, clothes, and general produce. Fronts Molesworth-street, but has its back entrance in a lane which also serves McDermott's store, mentioned in connection with previous cases. The back entrances of these two stores are not 20 yards apart. This store was cleaned and searched for rats by the shop employees under the continuous supervision of a Sanitary Inspector and a foreman in the service of the Department, on 1st, 2nd, and 3rd June. Lining boards were removed wherever necessary to give access, and manholes cut for future use. All stock on shelves or floors was turned over, and the whole of the premises sprayed with formalin.

Rats.—At the residence no rats; at the place of employment the proprietor stated that a freshly dead rat was found on 6th May, before my arrival at Lismore. In consequence of this, the back part of the store was overhauled by a gang of men under the Sanitary Inspector. 474 bags of general produce were handled and moved, but only one rat was caught, and no more dead rats found. After the occurrence of Case H, it was learned that a dead rat had been found on 30th May in the groceries department of the store. It is said to have been putrid, and to have been at once burnt, but no information of the matter was given me till two days latter. The date on which this rat was found was the date of attack of this Case H, who worked in the ironmongery department a few feet away. The concealment of this discovery raises a suspicion that other dead rats may have been found between 6th May and 30th May, but during the cleansing operations, 1st to 3rd June, no more carcases were found, though several enclosed spaces in the walls contained abundant rat dung. I have mentioned above the relation of this store with the back lane which serves McDermott's store also (*vide* Case A and seq.), and is connected by a defective box drain with Brown's Creek.

PART III.

PLAGUE IN RATS.

No unusual mortality among rats appears to have attracted attention until the occurrence in the beginning of May of the first human case of plague. Then it was learned that a considerable number—19 or 20—of dead rats had been found in McDermott's store on 22nd and 25th April. Subsequently, the general cleansing operations discovered putrid or mummified rat carcases on several premises in the same neighbourhood; but it seems improbable that the epizootic had been severe or long established before the occurrence of human cases. It should be mentioned that when plague first occurred at Ballina in February, Lismore rats to the number of 52 were examined for plague, with negative results.

On 5th May a mouse, found dead at some auction rooms in Woodlark-street, was examined by Dr. Corlis of Ballina, who, in the smears made from the spleen, found bacilli morphologically resembling *B. pestis*.

On 12th May I began examination of all rats and mice obtained either by cleansing gangs or by the rat-catchers. This examination was maintained until 5th July, first by myself, and after my departure from Lismore on 12th June by Veterinary Inspector J. F. McEachran, M.R.C.V.S. During this period 377 rats and 176 mice were examined (in addition to 367 rats and mice from other towns—Casino, Ballina, Coraki, and Ulmarra—sent to Lismore for examination).

On the first day of systematic examination, namely, 12th May, 2 rats and 1 mouse were found to be plague-infected. The last plague-infected rats or mice were examined on 13th June. Examination of all rats and mice was kept up for three weeks longer—till 7th July—but with negative results.

The following table shows the numbers of rats and mice examined and the number found infected week by week:—

	Week ending—								Total.
	May.		June.					July.	
	18th.	25th.	1st.	8th.	15th.	22nd.	29th.	6th.	
Examined—									
Rats	41	52	98	72	27	34	33	20	377
Mice	43	33	28	21	22	14	9	6	176
Infected—									
Rats	3	3	2	...	3	...	...	...	11
Mice	4	2	...	2	...	...	..	...	8

The available evidence thus indicates that the epizoötic existed from at least the middle of April until the middle of June following. During this time 11 rats and 8 mice of those submitted for examination were found to be infected, but there were many others found dead which were too putrid for satisfactory examination.

These rats and mice were obtained on 11 different premises. The map attached to this report shows the location of these premises, and the dates on which plague-infected rats or mice were obtained. The most striking fact about their location is that eight of the eleven premises are on the bank of, or in the immediate neighbourhood of, Brown's Creek, the watercourse mentioned above as forming the northern boundary of the business part of the town, and joining the river just above the main bridge and wharf used by the ocean steamers. The condition of this creek was such as to attract and harbour rats. For years the persons living on its banks had been accustomed to cast out here their rubbish and most of their house garbage, and besides this accumulation of miscellaneous refuse there was on the banks a thick undergrowth of lantana and other bushes. With a breeding-ground of this description in close proximity to the wharf, it was to be expected that the epizootic would manifest itself here if anywhere. Mention has already been made of the box-drain connecting this creek bank with the lane at the back of McDermott's store (*vide* Cases A, B, C, and D), and of the probability that the mortality among McDermott's rats in April was due to introduction of infected rats *via* this box-drain.

The eight premises in the neighbourhood of Brown's Creek were occupied as follows:—Hotels, 2; auction-rooms (produce, &c.) 3; hotel stables, 1; barber's shop (next to other auction rooms), 1; private stables, 1. The other three premises from which plague infected rodents were obtained were—Hotels, 2; private stables, 1; and 1 private residence in Uralba-street. The last-named place was distant more than half a mile from the nearest other place known to be infected, separated from this by unoccupied park land, and it appeared probable that the infection had been transported. The other three places were not so far distant or so separated as to preclude the idea that they might have become invaded by migrating plague-infected rats.

Besides these eleven premises, which furnished rats proved to be plague-infected, mention should be made here of the hotel premises on which the patient Connell (Case E) lived, where the licensee had found dead rats in the first week of May.

Whence the plague-infected rats were introduced into Lismore must necessarily be a matter for conjecture, but the most reasonable supposition is that they were brought up the river. At Ballina plague rats were found in February, April, and May, and at Woodburn in March, April, and May. The frequent communication by steamer between these places and Lismore has already been described and obviously offered abundant facilities for such transport of rats, despite all precautions, such as rat-guards, tarred mooring lines, &c.

Connection of cases with plague infected rats.—With the exception of Connell (Case E), of whose movements no one could give certain information, and who may have been infected at his place of residence, all the cases notified were connected either with McDermott's store or with the lane or premises at the rear. Cases A, C, and D had been employed in the store, Case B had been in the shop on the day when the dead rats were found, Case F had been for some hours hanging about watching the cleansing gang at work, Case G was one of the foremen directing this cleansing work, and Case H was employed in a neighbouring store whose back entrance was in the same lane.

It is worthy of note that none of the eleven premises abovementioned as furnishing plague-infected rats furnished patients also, and this although three were hotels and the other premises of such a character as to be much frequented.

PART

PART IV.

ADMINISTRATIVE MEASURES.

1. *Disposal of Patients.*

No difficulties in regard to this matter arose at Lismore. The patients were taken to the District Hospital and lodged in what used to be the main hospital, but is now empty since the erection of the new building. The hospital staff was supplemented by two nurses from the Coast Hospital who had had previous experience of plague. Medical care of the cases was undertaken by the medical staff of the hospital.

2. *Operations for the Cleansing and Disinfecting of Premises.*

These were initiated by the Council as soon as the first case was verified. Notices under Public Health Act, section 34, were served on all householders, requiring immediate cleansing, in default of which the Council would do the work at the expense of the householder. As a result of these notices, more than 100 loads of rubbish were carted by householders from private premises to the municipal tip. The majority of householders, however, did not themselves carry out the cleansing of premises, and for such the Council engaged a cleansing gang of thirteen men, who worked under the immediate direction and supervision of an experienced Sanitary Inspector and two foremen, despatched from Sydney by the Department for this purpose. This proved to be a satisfactory arrangement. The work comprised removal of all unnecessary lumber from yards and from under houses, search for and destruction of rats and rat-burrows, and thorough treatment with formalin spray, liquid carbolic, or chloride of lime, of all premises where rats were known or suspected to have been found dead. Note was taken of the time occupied in dealing with each place, and as soon as the work was finished the Council served the occupier with a bill for the cost of labour and disinfectants used. In most cases the charges were paid at once; but, in the few instances of refusal, the occupier was promptly served with a summons for a breach of the Municipal By-laws, in that he allowed filth to remain on his premises. In one case, in which the occupier refused to pay the original charge of 12s. 6d., he was fined £3, with 15s. costs.

When the premises throughout the town proper had been thus dealt with, Brown's Creek was taken in hand, and a complete clearance made of the dense undergrowth on its banks, more especially between Molesworth and Keen Streets.

Additional measures for destruction of rats comprised the setting of traps by an employee of the Council, who every morning brought his catch to be examined; and the free distribution at the Council Chambers of poison baits to all who chose to apply; but the total number accounted for was small, only 377 rats and 176 mice in eight weeks, and there was reason to believe that rats were not numerous in the town. In the beginning of June the Council advertised a capitation fee of 3d. per rat; but this did not cause any increase in the daily numbers delivered for examination.

3. *Quarantine and Trade Restrictions.*

Trade restrictions applied only to grain and fodder as being the goods most likely to favour the transport of rats. The export of these was prohibited unless the shipment went direct to Sydney, where special precautions as to fumigation could be ensured. With the object of preventing transport of infected rats from Lismore, the steamers regularly plying from Sydney to the Richmond River were fumigated with sulphur in Sydney every week, and the same treatment was applied to the Brisbane trader—s.s. "Pyrmont"—on her weekly visit to Lismore. It was not found necessary to "quarantine" any premises. Both the large general stores which furnished plague patients were closed by their proprietors voluntarily during the cleansing operations.

R. J. MILLARD,
Assistant Medical Officer of Government, and Assistant Microbiologist.

REPORT

PREPARED FOR THE DEPARTMENT OF PUBLIC HEALTH.

MAP
OF THE
TOWN OF LISMORE.

SCALE

CHAINS 10 — 0 — CHAINS 10

Showing the places at which plague-infected rodents were taken in 1905, the places at which persons who had plague were employed, and the places where they resided.

NOTE.—Places at which plague-infected rodents were taken—consecutively numbered in accordance with the date on which the first was taken at each place—are shown thus ·6

Places at which persons who had plague resided Ⓐ

do do do do do were employed A

TABLE showing the places at which, and the first and last dates on which, plague-infected rodents were taken in Lismore. The entries are consecutively numbered in accordance with the dates on which they were first taken. References to the eight cases which occurred in Lismore are inserted in the series in their order according to their attack dates.

No.	Place.	Infected Rodents taken.				First.	Last.
		Total.	M. Dec.	M. Rattus.	M. Mus.		
	CASE A.—Attacked, 1-5-05.						
	CASE B.—Attacked, 1-5-05.						
	CASE C.—Attacked, 3-5-05.						
1	Auction Rooms, Woodlark-street	1	...	...	1	5-5-05	......
	CASE D.—Attacked, 7-5-05.						
	CASE E.—Attacked, 7-5-05.						
	CASE F.—Attacked, 9-5-05.						
	CASE G.—Attacked, 11-5-05.						
2	Commercial Hotel, Woodlark-street	2	...	2	...	12-5-05	......
3	Frazer's Auction Rooms, Woodlark-street	1	...	...	1	12-5-05	......
4	Dr. Franceschi's stables	1	...	1	...	17-5-05	......
5	McGregor Dunn's Auction Rooms	5	...	...	5	18-5-05	19-5-05
6	P. Flaherty's, Woodlark-street	1	...	1	...	20-5-05	......
7	Cook's stables	2	1	1	...	20-5-05	24-5-05
8	Wightman's Hotel	2	...	2	...	30-5-05	......
	CASE H.—Attacked, 30-5-05.						
9	Hotel Metropole, Keen-street	1	...	...	1	2-6-05	......
10	Hewitt's, Uralba-street	1	...	...	1	6-6-05	......
11	Dr. Duka's stables	3	2	1	...	13-6-05	......

R. J. Millard
M.B. Ch.M.
D.P.H.

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19 JUN. 1923
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REPORT

ON AN

Outbreak of Plague at Newcastle, New South Wales, 1905.

By ROBERT DICK, M.B., Ch.M. (Syd.), D.P.H. (Camb.),
Medical Officer of Health for the Hunter River Combined Sanitary Districts.

The Medical Officer of Health, Hunter River District, to the President of the Board of Health.

GENERAL CONDITIONS AT NEWCASTLE.

7 November, 1905.

THE City of Newcastle is placed on the south side of the river Hunter at its termination in the South Pacific Ocean, in latitude 32·57 S., 70 miles north of Sydney by sea. Population of city—census 1901—14,250, present estimated population, 15,000. Population of district, including immediate suburbs—census 1901—43,269. Present estimated population, 45,800. The tonnage entered during 1904 was 2,086,873.

2. The trade of the city is principally concerned with the shipment of coal produced from the many coal mines in the district. The city also acts as a large distributing centre for the northern parts of the State. It is in daily communication by rail and sea with Sydney, and at short intervals with the northern ports of the State, with Queensland, and with the rest of the Commonwealth, as well as with many other parts of the world.

3. In Newcastle itself, there are many old and ill-kept buildings, though these have been somewhat reduced in numbers, as a result of proceedings under the Public Health Act, during the past five years.

4. The city and district are provided with an abundant supply of good water for drinking and domestic purposes.

5. About three-quarters of the city is sewered, but the sewers and drains, originally constructed for stormwater purposes only, are very defective, and with few exceptions, discharge on to the foreshores of the harbour, under the wharfs, where they are a fruitful source of nuisance. It is clear that these arrangements are attended with grave danger, when considered in relation to plague, and its association with rats. A new sewerage system for the city and district, is now under construction, but after this is provided, the old sewers will, no doubt, be retained for the conveyance of storm waters.

6. A considerable area of the foreshores of the harbour, especially on the city side, has been reclaimed by means of stone ballast, and the shores under the wharfs are faced with this material, which affords ample scope for the harbourage of rats.

EARLIER CASES OBSERVED AT NEWCASTLE.

7. The year 1900 was marked by the first recorded appearance of plague in Australasia. In Sydney, during that year, 303 cases of the disease were notified, of which 103 proved fatal. Cases of the disease have been reported in the metropolis during each succeeding year, down to the present time.

8. In 1902, two cases of the disease were notified at Newcastle. The first was that of F.J., m., æt. 43 years, employed as steward on board the barque "Eulomene." This vessel arrived in Port Hunter, from Sydney, on 7th March, 1902. On 17th March (ten days after her arrival) F.J. was taken ill, and was removed to Newcastle hospital, and later to the Quarantine hospital at North Stockton. On 19th March, the case was diagnosed as bubonic plague. Left axillary bubo, morphological, cultural, and inoculation tests positive. The attack proved a mild one. He was discharged from hopital, cured, on 20th April, 1902. No further cases occurred amongst the other 22 persons forming the ship's company. (See Report, Sydney, 1902, pars. 66–73.)

9. The origin of infection in this case, was attributed to Sydney.

10. The second, and that, apparently, an indigenous case, happened in the person of T.O'N., m., æt. 19, single, no previous attack, not inoculated, employed continuously for about three months prior to attack as porter and cellarman at an hotel, in Hunter-street, Newcastle. Date of attack, 3rd August, 1902, admitted to hospital, 4th August, 1902, died 7th August, 1902; duration of illness, 4 days. Left femoral bubo, morphological, cultural, and inoculation tests positive. The source of infection in this case was not clear. The patient was employed as porter and cellarman at a large hotel in the principal business centre of the city. As part of his work he was in the habit of opening out, handling, and repacking commercial travellers' goods obtained from many different sources in Sydney, in which city 139 cases of plague had been notified between January and 30th June, 1902, and plague-infected rats continued to be found down to 14th July, 1902. He was also employed regularly in the cellar of the hotel several hours a day. The floor of this cellar was found riddled with rat runs, and contained a defective drain leading to a sewer, which ran under the wharf, discharging on to the foreshores at a point about 150 yards distant from the hotel. Steamers which ply daily from Sydney are moored at this wharf. Whilst in Sydney they lay at a wharf about which numbers of plague-infected rats continued to be found. The licensee of the hotel and the patient stated that a number of dead rats had been found and removed from the cellar of the hotel during a week or ten days prior to the onset of the patient's illness. No poison had been laid about the hotel premises. During the cleansing of this cellar by the cleansing staff two dead rats were discovered, but they were in an advanced stage of decomposition, and were useless for the purposes of bacteriological examination. No further cases of the disease occurred amongst the inmates of the hotel, and no other cases were reported in the city or district. (See Report of the Board of Health on "A Second Outbreak of Plague at Sydney, 1902," by Dr. Ashburton Thompson, pars. 183–193.)

11. Following on the notification of this case of plague, a systematic examination of rats procured from different parts of the city was undertaken. A rat staff consisting of twelve men, organised on 8th August, obtained 1,598 rats from 125 different premises in the city, all of which were examined by me, but none of them were found infected.

12. Prior to 8th August, 1902, the destruction of rats had been carried out to some extent in the Newcastle district. During the period 11th May to 30th June, 1901, 32,581 rodents had been destroyed in the incinerator. The work was resumed on 6th March, 1902, and was continued to 11th September, 1902. During this latter period, 14,901 rodents were destroyed in the incinerator; but, with the exception of the 1,598 rats procured by the rat staff between 8th August and 11th September, 1902, no systematic examination of rodents was carried out in Newcastle.

13. Since the notification of the last-mentioned case (T.O'N.), in Newcastle, on 4th August, 1902, no further case of plague was reported down to 25th March, 1905.

THE OUTBREAK, 1905.

14. The circumstances surrounding the fourteen cases of plague, comprising the present epidemic, may be set out as follows:—

Case A.

Summary.—G.P., m., æt. 23, unmarried; no previous attack; not inoculated; no communication with any previous case. Notified by the Resident Medical Officer, Newcastle Hospital, as a suspicious case of plague, at 5 p.m., 25th March, 1905; visited by me, 7 p.m., 25th March. Discharged from hospital, cured, 26th April, 1905; duration of illness, 35 days. Right femoral bubo; morphological, cultural, and inoculation tests positive; guinea pig inoculated subcutaneously in thigh with fluid drawn off from bubo, died of plague in 76 hours.

Resided with parents at 83, Darby-street, and employed as assistant in a produce store at 183, Hunter-street.

Movements prior to Attack.—Continuously employed as assistant in the produce store referred to, for more than a year; occupied in stacking, weighing, and loading pollard, maize, oats, and other forms of produce on the second and third floors of the main store. Usually took his dinner to the store, and ate it there.

History of Illness.—Worked regularly at the produce store up to 22nd March, when at about 3 p.m. on that date, whilst at work, he got headache and felt a sharp pain in his right groin. There was no vomiting or shivering. He stayed about the produce store till 5 p.m., when he walked home, a distance of about half-mile, and lay down in bed, and remained there during 23rd and 24th March. On 23rd March, a painful swelling developed in the right groin, and increased in size during 24th and 25th March. On the latter date he walked up to the Newcastle Hospital, a distance of about a mile from his home, and presented himself for treatment in the out-patient department. He had not been attended by a medical man whilst he lay ill at home. On examination by the resident medical officer at the hospital, the case was looked on as suspicious of plague, and he was admitted. On examination by me at 7 p.m. that evening, he was found to be fairly alert, and gave a coherent account of his movements and of the onset of his illness. Tongue coated down centre with whitish fur. In the right femoral region there was an enlarged and tender gland the size of a walnut, with slight periadenitic thickening about it, and the skin over the gland was somewhat reddened. There were several flea-bites down the front of the right lower extremity, and one conspicuous immediately superficial to the bubo. Temp. 101 ; P. 96. The attack proved a mild one, the temperature dropping to normal on the third day after admission to hospital. The bubo broke down, and took a long time to heal.

Residence.—A two-storied semi-detached weatherboard building, clean, and in good repair ; connected to sewer ; defective D trap on drain ; pail closet, no trade carried on ; no stables. Disinfected 26th March, 1905.

Employment.—A large semi-detached three-storied brick building, portion of the ground and first floors being devoted to offices, and the remainder to the business of a produce store, butter and bacon factories. The building was in good repair ; connected to sewer. On the ground floor there was a wooden platform with a space of about 1 foot between it and the earth, and one of the upper floors was ceiled in part. There were large stocks of maize, oats, flour, pollard, and other forms of produce and groceries stored on the second and third floors of the building where the patient worked. The butter and bacon factories were placed in wings connected to the main store, the former opening direct off the first flat.

Rats.—At residence, no signs. At employment, during the overhaul by the cleansing gang of the produce on the second floor where the patient worked, 2 plague-infected rats were found on 29th March. On the ground floor of the building, under the wooden platform referred to above, 2 plague-infected rats had been discovered, together with the putrid carcases of 40 other rats, on 28th March. On another detached part of this produce store, separated from the main store by a narrow street, 2 more plague-infected rodents were discovered on 7th April (it was in this part of the establishment that Case E worked), whilst in two dwellings, forming part of a terrace of houses abutting on the main store, 6 plague-infected rats were found, together with the putrid carcases of 12 other rats, between 31st March and 4th April.

Contacts and further Cases.—At residence, 4 ; employed in same parts of main store as the patient, 10. No further cases occurred amongst these persons. Case E was also employed at this produce store, but in that detached part of it referred to above where 2 plague-infected rodents, as well as a number of putrid and desiccated carcases of rats, were discovered between 1st and 7th April.

Case B.

Summary.—W.McK., m., æt. 16, unmarried, no occupation. Resided with his parents at 181, Hunter-street, Newcastle. No previous attack ; not inoculated. Notified by Dr. J. L. Beeston at 10 a.m., 27th March ; visited by me at 11 a.m., 27th March. Admitted to Newcastle Hospital, 28th March ; died, 2nd April ; duration of illness, 8 days. Left femoral bubo ; morphological, cultural, and inoculation tests positive. A guinea-pig inoculated subcutaneously in thigh with fluid withdrawn from bubo died of plague in seventy-two hours. His parents kept a pastrycook shop next door to the produce store at which Case A worked. The third floors of these two premises were in direct communication with each other through holes in the parti-wall, whilst the yard of W.McK.'s residence abutted on the wall of the produce store and opened on to a common passage leading from the ground floor of the produce store. This passage was boarded over in continuation with the wooden platform referred under Case A.

Movements prior to Attack.—Left Newcastle for Sydney on 19th March, 1905, and stayed at Park-road, Paddington ; returned to Newcastle at 8 p.m. on 22nd March, 1905. During his stay in Sydney did not visit any wharves there, nor was there any history of plague in rats or man at his place of abode whilst in the metropolis. Did not visit the produce store next door to his residence in Newcastle, nor did he know Case A.

History of Illness.—Began with sudden onset on 25th March, 1905 ; experienced headache, but no vomiting or shivering. A painful condition of the left groin followed, and a tender swelling was felt in this region on the evening of 25th March, 1905. During 26th March, 1905, headache continued, and the swelling in the left groin increased in size, and was associated with some periadenitic effusion. No lesions noticeable on the left lower extremity. The furthur course of his illness was marked by great increase in size of the bubo, with very extensive inflammatory œdema spreading up on to the abdomen and down on the thigh. Two days prior to death, painful swellings formed in the scalp tissue ; one of these, on being incised, was found to consist of gelatinous material, swarming with *B. pestis* ; delirium marked during last three days of illness. Received 380 c.c. Yersin's serum during the course of his illness.

Residence.—A two-storied brick building, wedged in between a produce store and seedsman's shop, the ground floor being devoted to a pastrycook's shop and refreshment room. Premises in good repair and generally clean ; connected to sewer. Disinfected, 29th March, 1905.

Employment.—Nil ; he had recently left school, and was waiting engagement in connection with office work.

Rats.—At residence, his parents stated that in the bedroom usually occupied by the patient there had been, for the week previous to his attack, a very foul odour, which they ascribed to dead rats. On search being made by the cleansing gang, on 29th March, 1905, one dead mouse was found under the flooring of this room, and three dead rats over the ceiling of it. All four were in an advanced state of decomposition. There was direct connection between these premises and the produce store next door, on which several plague-infected rats, and many putrid dead carcases of rats, were found, as detailed under Case A.

Contacts and further Cases.—At residence, 8. No further cases occurred.

Case

CASE C.

Summary.—R.K., m., æt. 18, unmarried. No previous attack; not inoculated; no communication with any previous case. Notified by Dr. A. J. C. Crawley, 9 p.m., 28th March, 1905; visited by me, at 10 p.m., 28th March, 1905; admitted to Newcastle Hospital, 29th March, 1905; discharged cured, 27th May, 1905; duration of illness, 60 days. Resided with his parents at 202, Darby-street, Newcastle, and worked as attendant on a biscuit-moulding machine, at a large biscuit factory employing about 700 hands, situated in Melville-street, about a half mile distant from his residence. Left femoral bubo; morphological, cultural, and inoculation tests positive. A guinea-pig inoculated subcutaneously with fluid drawn off from the bubo died of plague in 74 hours.

Movements prior to Attack.—Woke on the morning of 28th March, 1905, feeling quite well, and went to his work as usual at 7 a.m. At 8 a.m. he felt sick, and reported himself to the foreman of the particular branch of the work at which he was employed in the biscuit factory, who told him to go home. Arrived home at 9 a.m. in a delirious condition, and could not give his parents any account of himself. When seen by me at 10 p.m., 28th March, 1905, at his home, he had noisy delirium, and lay curled up in bed, resisting any movements of his limbs. Pressure in the left femoral region excited much distress, and here there was to be felt a somewhat enlarged gland; T. 103, P. 100; body very dirty, with numerous flea-bites present on the limbs. Bubo broke down, and took a very long time to heal. Received 120 c.c. Yersin's serum during the course of his illness.

Residence.—A detached weatherboard cottage in poor repair, abutting on a large stable and produce store, and adjoining a marine dealer's premises; pail closet, but premises connected with sewer, the house-drain being structurally defective. Fowl-house and shed in yard, together with stacks of secondhand timber. Premises disinfected 29th March, 1905.

Employment.—A large, well-appointed, and structurally sound building, at which about 700 hands, male and female, were employed; connected with sewer; stables in yard at rear.

Rats.—At residence, 4 rats, 1 plague-infected, were caught on 1st April, 1905. At the marine store adjoining, 2 plague-infected rats were taken on 4th April, 1905, and at premises next to this, 1 plague infected rat was found on 1st April, 1905.

At Employment.—No traces of rat-infestation in that part of the factory where the patient was regularly employed. Some evidences of them, however, in the flour store, and about the latrines, as well as in that part of the building devoted to offices. Though many attempts were made to obtain rats for examination from these premises, none were procurable. There was no history of dead rats having been seen in any part of the establishment.

Contacts and further Cases.—At residence, 3; at employment (in that part of the building where the patient regularly worked), 43. No further cases occurred at the residence. Case N present series (date of attack, 2nd July, 1905), was employed at the same factory, but in a different part of the building.

CASE D.

Summary. G.M., m., æt. 23, unmarried. No previous attack; not inoculated; no communication with any previous case; employed as yardman in a marine store at 91, Dawson-street, Newcastle. Resided with parent at 14, Queen-street, Newcastle. Notified by Dr. W. Nickson, 10 a.m. 2nd April, 1905; visited by me, 12 noon, 2nd April, 1905; admitted to Newcastle Hospital, 1st April, 1905; discharged cured, 12th May, 1905; duration of illness, 42 days. Left femoral bubo; morphological and cultural tests positive.

Movements prior to Attack.—Worked regularly at the marine store referred to, handling bags, rope, and other articles usually associated with such trade; so employed during several months past.

History of Illnesses—On 31st March, 1905, was carting some rubbish away from the marine store premises, when he was suddenly attacked by vomiting and frontal headache: had to leave off work, and went home to bed; lapsed into a stupid condition, and it was thought by his people that he had had a fit. On 1st April, 1905, felt pain in left groin, and a swelling was noticed there, which rapidly increased in size and was attended by considerable pain. On admission to hospital, bubo was as large as a walnut, very tender; temperature, 103; body in a very dirty and ill-kept condition; numerous flea-bites on both lower extremities, and a number of discharging sores on feet and hands; received 140 c.c. Yersin's serum; gland broke down and took a long time to heal.

Residence.—A semi-detached weatherboard structure in poor repair, fairly clean; connected to sewer; pail closet; no stables or sheds in the immediate vicinity. Premises disinfected 2nd April, 1905.

Employment.—At a marine dealer's premises, which were in a generally dirty and ill-kept state. They adjoined a large produce store and stables.

Rats.—At residence, no traces. At employment, many evidences; 2 plague-infected rats were taken there on 5th April, 1905, during cleansing operations, and 1 plague-infected rat on the premises next door on 1st April, 1905.

Contacts and further Cases—At residence, 8; at employment, 4. No further cases occurred amongst any of these persons.

CASE E.

Summary.—D.D., m., æt. 44, married. No previous attack; not inoculated. Resided in the suburb of Lambton, distant about 4 miles from his place of employment, which was at the produce store in Hunter-street, Newcastle, where Case A worked, though in a different part of those premises. D.D. acted as storeman in charge of that portion of the premises devoted to hay, chaff, and potatoes, across a narrow street and opposite the main store. Died at his residence 27th April, 1905. Duration of illness, 5 days. Septicæmic case; *B. pestis* recovered from spleen and liver at post mortem.

Movements prior to Attack.—Employed for many years past as storeman, handling hay, chaff, and other produce at the produce store referred to. Journeyed daily between his residence at Lambton and his place of employment, and confined himself to that part of the store where he was in charge. Usually took his dinner to the store and ate it there.

CASE F.

J.R.L. Age, 26. Occupation, med. practitioner.
Admitted, 30-4-05. Discharged, 28-5-05. Result, cured.

TEMPERATURE CHART.

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History of Illness.—Worked regularly at the produce store up to 21st April, 1905. Left home for work at 6 a.m. on 22nd April, 1905, but soon after starting was suddenly taken with vomiting. He returned home by tram at 8 a.m. and took to bed. Was seen by a medical man (J.R.L., Case F) on 24th April, 1905. At that time T. 104, P. 120; vomiting a prominent symptom. Died at 5 a.m. 27th April, 1905. The cause of death not being clear the matter was referred to the Coroner, who ordered a *post-mortem*, which was done at 3 p.m. 27th April, 1905, in the Morgue, Newcastle. The *post-mortem* disclosed no obvious lesions on the surface of the body and no apparent enlargement of the superficial groups of glands. The viscera were much congested; blood-stained fluid in pleural and peritoneal sacs; spleen much enlarged, very soft, and with small greyish spots showing on its surface. Smear preparations from the spleen and liver showed swarms of typical *B. pestis*.

Residence.—A detached stone cottage, in good repair and clean; no drains; pail closet; no trade carried on; no stables present. Disinfected, 28th April, 1905.

Employment.—That part of the produce store in Hunter-street, Newcastle, at which he was employed consisted of a series of sheds in very poor repair, with wooden and earthen floors. About 500 tons of produce of various kinds were stored there.

Rats.—At residence, no signs. At employment, in one of the sheds where the patient spent most of his time, 2 plague-infected rats, as well as a number of putrid and desiccated carcases of rats, were discovered on 7th April, 1905, during cleansing operations. No further plague-infected rats were caught or found on these premises after that date, though they were searched. But it is to be noted that this produce store faces the wharves and is distant from them by about 100 yards in a direct line, and that the main sewer (4 feet by 4 feet, square in section) serving the block in which these premises are placed, and the premises themselves discharges, open-mouthed on the foreshores of the harbour. Plague-infected rats continued to be caught about the mouth of this sewer down to 13th May, 1905.

Contacts and further Cases.—At residence, 10; at employment (in that part of the produce store where the patient was occupied), 6. No cases occurred amongst any of these persons.

CASE F.

Summary.—J.R.L., m., æt. 26, unmarried, medical practitioner. No former attack; not inoculated. Notified by Dr. F. H. Cox, 9 a.m., 30th April, 1905; visited by me, 10 a.m., 30th April, 1905; admitted to Newcastle Hospital, 30th April, 1905; discharged cured, 28th May, 1905; duration of illness, 31 days. Was engaged in private practice at Lambton, a suburb 4 miles out of Newcastle.

Movements prior to Attack.—He attended the patient D.D. (Case E, present series) from 24th to 27th April, and made the *post mortem* on that case. Left axillary bubo; morphological and cultural tests positive.

History of Illness.—On 27th April, about 4 p.m., during the performance of a *post mortem* on Case E at the Morgue, Newcastle, he made a slight scratch on the skin at the base of the left forefinger, and at the same time two small pieces of skin were knocked off at the base of the right thumb. The latter wounds bled freely and were mopped with pure carbolic acid; the slight scratch on the left hand was not noticed at the time. At 4 p.m., 28th April, 1905, he felt some *malaise*, and experienced frontal headache. During this day, and on 29th April, 1905, he went about his ordinary medical duties, driving out and seeing a number of patients. On the evening of 29th April, 1905, he experienced some pain high up in the left axilla, and felt a slightly enlarged gland there. This increased in size during the night of the 29th, and was accompanied by considerable pain. He passed a restless night. When visited at 10 a.m. on 30th April, 1905, at his residence, he complained of headache and pain in the left axilla. He was dull, with suffused eyes, tongue clean and moist, skin moist; T. 102, P. 120. In the left axilla there was an enlarged and very tender gland, soft to the touch, about the size of a large walnut, with very little periglandular thickening about it. At the base of the left forefinger there was present a small wound with slightly everted edges, which was now recognised as having been made at the *post mortem*. There was no lymphangitis about the wound or up the left arm. Puncture of the bubo yielded *B. pestis* in pure culture. The further course of his illness was very severe. The temperature rose to 105, and continued between 101 and 104 for five days, when it dropped to 99. This intermission was succeeded by a further rise to 100–101, maintained for nine days, when it gradually subsided to normal. The gland increased very considerably in size, and it, with inflammatory œdema, filled the upper part of the axilla. The swelling slowly subsided, and resolved without breaking down. The subcutaneous injection of Yersin's serum was begun on 30th April, 1905, at 10 a.m., and was repeated at four-hour intervals. Altogether 944 c.c. of the serum were given. Very acute muscular and joint pains and a sharp attack of urticaria followed. The temperature chart and other clinical details of this case will be found in the Appendix attached to this Report. It is worthy of note that there was no invasion through the two wounds on the right hand which bled freely, and which were swabbed with pure carbolic acid soon after their infliction.

Residence.—A detached weatherboard cottage in good sanitary state. Bedroom disinfected 1st May, 1905.

Rats.—At residence, no signs.

Contacts and further Cases.—At residence, 4. No further cases occurred.

CASE G.

Summary.—E.C.J., m., æt. 17, unmarried, stable boy and carter. No previous attack; not inoculated. No communication with any previous case. Notified by Dr. N. J. Dunlop, 10 p.m., 3rd, May, 1905; visited by me, 9 a.m., 4th May, 1905. Admitted to Newcastle Hospital, 4th May, 1905; died, 6th May, 1905; duration of illness, 3 days. Resided with parents off Corlette-street, Newcastle, and worked in a pastrycook's, at 191, Hunter-street, West Newcastle. Right inguinal bubo; morphological and cultural tests positive.

Movements prior to Attack.—Was engaged as carter delivering pastrycook's goods about the city and district, and looked after the horse and cart used in connection with his work. Had been thus employed for several months. The stable at which his horse was fed and stalled lay at some little distance from the pastrycook's shop, on premises used as a furniture and upholsterer's store. The yard of these premises, 199-201, Hunter-street West, adjoined that of a butcher's shop next door, 203-205, Hunter-street West, on which there were a number of stables. These two yards were only partially separated from each other by a dilapidated wooden fence, the entrance to the stable on the upholsterer's premises being through the yard attached to the butcher's shop. Case G frequented the stable at which his own horse was tended, as well as the yard attached to the butcher's shop.

History of Illness.—Went to his work at 7·30 a.m. on 3rd May, 1905. At 8·30 a.m., whilst on his cart delivering goods, he felt ill, shivery, and inclined to vomit. He remained at his work, however, till 3 p.m., when he walked from his place of employment at the pastrycook's shop to his home, a distance of about half a mile. Arrived home in a more or less stupid condition. Complained of headache and pain in right groin. Was very delirious on night of 3rd May, 1905. On examination, 9 a.m., 4th May, 1905, he was found in a stupid condition, tongue moist, coated down centre with thick fur. In right inguinal region an enlarged gland about the size of a shelled almond, with very little periadenitic thickening about it; much distress evinced when the gland was palpated. No lesion apparent on drainage area of bubo. T. 105, P. 120. The further course of his illness was marked by considerable increase in size of the bubo, with inflammatory thickening about it; delirium very marked, and restlessness extreme. Death from heart failure on 6th May, 1905, three days after the onset of his illness. Received 380 c.c. Yersin's serum, spread over thirty hours.

Residence.—A detached weatherboard cottage in good repair and very clean; connected with sewer; some stables on the adjoining premises. Premises disinfected, 4th May, 1905.

Employment.—Pastrycook's shop a semi-detached brick building in fair repair, and generally clean; baking-room with bricked floor; no outhouses; connected with sewer. The stable was in very poor repair; earthen floor; no drainage.

Rats.—At residence, no traces; at employment at the pastrycook's shop, one or two rat-holes were present, but no recent traces of rats. At the stable, rats were numerous. One plague-infected rat was caught there on 20th April, 1905, and 4 were taken in the yard attached to the butcher's shop, 1 on 25th April, 1905, and 3 on 1st May, 1905. The butcher's shop premises were overrun with rats, no less than 67 being killed during cleansing operations, whilst in addition a number of putrid carcases of rats were found there.

Contacts and further Cases.—At residence, 4; at employment at pastrycook's shop, 6. No further cases occurred amongst these persons.

CASE H.

Summary.—W.McM., m., æt. 43, married, butcher. No previous attack; not inoculated. Notified by Dr. A. J. C. Crawley, 11 a.m., 6th May, 1905. Admitted to Newcastle Hospital, 6th May, 1905; discharged cured, 6th June, 1905; duration of illness, 43 days. Resided at No. 6, Auckland-street, Newcastle, and worked as butcher in the butcher's shop at 203-205, Hunter-street West, Newcastle, next door to the furniture and upholsterer's premises referred to under Case G. Left femoral bubo; morphological and cultural tests positive.

Movements prior to Attack.—Was employed in butcher's shop, where he had worked regularly for several years past. Engaged in the retail portion of the shop and the small goods factory which opened off the rear of the shop; occasionally went about the yard and stables attached to the premises. Knew Case G, but was not in the habit of associating with him.

History of Illness.—Went to his work on 5th May, 1905, in the morning in his usual health. About 10 a.m. he experienced pain in the left groin, with headache and shivering. He walked home, a distance of about a sixth of a mile, and went to bed at 1 p.m. On examination on 6th May, 1905, at noon, T. 103, P. 120, tongue clean, but tending to dryness. A bubo the size of a large marble and surrounded with inflammatory œdema formed a definite prominence in left Scarpa's triangle. No lesions apparent on drainage area of bubo. The bubo finally broke down. Received 680 c.c. Yersin's serum during course of illness.

Residence.—A two-storied brick building, forming one of a terrace, in good repair and generally clean; connected to sewer; pail closet; large stable premises six doors away and on the same side of the street.

Employment.—A brick building used as a butcher's shop, with wooden floors throughout, except in that part of the premises used as a small-goods factory, where there was a poorly-laid brick floor. Stables in the yard at rear in bad repair, earthen floors, very offensive, a large accumulation of manure and refuse about the premises; connected with sewer, but a large square-shaped bricked junction pit just off the small goods factory was found untrapped and without proper cover.

Rats.—At residence, no traces. At employment, premises badly infested. One plague-infected rat identified on 25th April, 1905, 3 on 1st May, 1905, whilst many putrid carcases of rats were discovered during cleansing operations on lifting the wooden floors in different parts of the shop and about other parts of the premises, and 67 rats were killed during these operations. The defective junction pit connected with the drains allowed free ingress and egress to rats. The sewer into which the drains led discharged on the foreshores of the harbour about 100 yards distant, and at a point opposite to the butcher's shop. Plague was identified in 6 rats caught near the spot where this sewer discharges on the foreshores between the dates 18th April, 1905, and 25th April, 1905.

Contacts and further Cases.—At residence, 7; no cases developed amongst any of these persons. At employment, 9; 1 further case, that of D.S., case I, occurred amongst the workmen at the butcher's shop.

CASE I.

Summary.—D.S., m., æt. 17, unmarried. No previous attack; not inoculated. Notified by Dr. A. J. C. Crawley, 6·30 p.m., 13th May, 1905; visited by me, 8·30 p.m., 13th May, 1905; admitted to Newcastle Hospital, 14th May, 1905; discharged cured, 31st May, 1905; duration of illness, 21 days. Resided with his parents at William-street, North Waratah, distant 4 miles from his place of employment at the butcher's shop, 203-205, Hunter-street West, Newcastle, where W. McM., Case H., was employed Left femoral bubo; morphological and cultural tests positive.

Movements prior to Attack.—Was employed as stable boy and carter at the butcher's shop, looking after the horses, and was also employed carting meat from the slaughter-house at North Waratah to the butcher's shop. Had been thus employed for several months.

History of Illness.—At 5 p.m., 11th May, 1905, just after finishing carting scrap meat from the butcher's shop to the slaughter-house at North Waratah he had a shivering attack and slight vomiting. He walked home, a distance of about half a mile, and lay down in bed. A painful swelling in the left groin was noticed on the morning of the 12th May, 1905. This gradually increased in size. No medical man was called in to attend the patient until 13th May, 1905, when Dr. Crawley saw him and notified the case to me. On examination at 8 p.m., 13th May, 1905, he was found in bed with suffused eyes and intolerant of light, tongue thickly coated down centre with fur; T. 102, P. 100. In left femoral region there was an enlarged and very tender gland the size of an unshelled almond; no lesions apparent on drainage area of bubo. The case pursued a mild course, and the bubo subsided without going on to suppuration. Received 160 c.c. Yersin's serum in 16 hours.

Residence.—A detached weatherboard cottage in fair repair and generally clean; no drains; pail closet; a detached milk-room and stable at rear. The father of the patient carried on the business of a registered milk vendor. He received milk from a farm in another part of the district, and distributed it in Newcastle and suburbs. The milk was met at the jetty on the river near by, the vendor then started on his rounds and rarely returned any milk for storage at his registered premises in Waratah.

Employment.—As set out under Case H.

Rats.—At residence, no traces. At employment, as set out under Case H.

Contacts and further Cases.—At residence, 4; at employment, 9. No further cases occurred amongst any of these persons.

Case J.

Summary.—D. McL., m., æt. 35, married. No previous attack; not inoculated; no communication with any previous case. Notified from Newcastle Hospital by the Resident Medical Officer on 21st May, 1905, at 1 p.m.; visited by me, 4 p.m., 21st May, 1905. Admitted to Newcastle Hospital, 21st May, 1905; discharged cured, 16th June, 1905; duration of illness, 29 days. Resided at Nobbys-road, Newcastle, and employed as storeman at a large general merchant's premises in Bond-street, Newcastle. Right inguinal bubo; morphological and cultural tests positive.

Movements prior to Attack.—Was employed as storeman on first and second floors of a large general merchant's premises in Bond-street, where groceries were principally handled. Had been so employed for several years past. Last at work, 19th May, 1905, at 5 p.m.

History of Illness.—At 7 p.m. 19th May, 1905, after having had his tea, he experienced sharp pain in right groin and had a shivering attack. Took to bed, and suffered from severe headache. On 20th May, 1905, felt painful swelling in right groin. Seen by medical man 21st May, 1905, and admitted to hospital same day. When examined after admission to hospital he was found with suffused eyes, tongue dry and coated down centre with thick white fur; temperature, 101. In right inguinal region painful gland, size of unshelled almond, slight amount of inflammatory œdema about it, and redness of skin superficial to it. No lesions apparent on drainage area of bubo. Gland increased in size and broke down.

Residence.—A detached weatherboard cottage in good repair and clean; no drains; pail closet; no stables. Disinfected 21st May, 1905.

Employment.—A large detached three-storied brick building, in sound repair, used by general merchants. One end of the building is a bonded store. Portion of the ground floor used as offices in connection with the business. The merchandise dealt with consisted of hardware, timber, groceries, and in a detached galvanized iron shed at the rear, articles of produce, such as chaff, hay, maize, &c., were stored. The basement floors were of concrete, but with wooden platforms 6 inches high over them; the rest of the floors were of wood. The first floor was the only one with a ceiling to it. There were double partitions separating different sets of offices on the ground floor. Connected with sewer.

Rats.—At residence, no traces; at employment, many evidences. On the two floors of the main store where the patient worked, 7 plague-infected rodents were taken between 3rd May, 1905, and 25th May, 1905. In the ceiled part of the first floor, which was searched, the carcases of 4 putrid rats were found. Two of these were lodged immediately under that spot where the patient sat at his desk, and where a part of the flooring was defective, a board having been left up next the wall against which the desk was placed. Two plague rats were also identified amongst those found in the shed at the rear where produce was stored on 8th May, 1905.

Facing the main building, on the opposite side of Bond-street, which is a narrow thoroughfare, are a row of sheds in which a large amount of produce was stored. In these sheds 11 plague-infected rats were found during the period 24th May, 1905, and 1st June, 1905. And in another produce store in Telford-street, at its junction with Bond-street, and opposite the western end of the main store, 6 plague-infected rats were taken between 15th May, 1905, and 30th May, 1905.

Contacts and further Cases.—At residence, 5; at employment (in that part of the building where the patient usually worked), 4. No further cases occurred amongst any of these persons.

Case K.

Summary.—S.E.T., m., æt. 19, unmarried. No previous attack; not inoculated; no communication with any previous case. Notified by Dr. J. L. Beeston, 10 p.m., 27th May, 1905; visited by me, 10 a.m., 28th May, 1905. Admitted to Newcastle Hospital, 27th May, 1905; discharged cured, 28th June, 1905; duration of illness, 34 days. Resided at the Railway Refreshment-room premises, Newcastle, where he was employed as porter and useful hand. Right inguinal bubo; morphological and cultural tests positive.

Movements prior to Attack.—Employed for several years past as porter and useful hand about the kitchen and yard premises at the Railway Refreshment Rooms, Scott-street, Newcastle. Last at work, 9 p.m., 26th May, 1905.

History of Illness.—At 9 p.m. 26th May, 1905, three hours after his tea, he had an attack of vomiting, followed by headache. Rose at 6·30 a.m., 27th May, 1905, and started his ordinary work, but was obliged to give up at 8 a.m. on account of faintness and painful condition of the right groin. Seen by medical man at 12 noon. On admission to hospital was found with dry tongue; T., 103; P., 108; in right inguinal region an enlarged and tender gland the size of a filbert, with small amount of thickening surrounding it; no lesion apparent on the drainage area of the bubo. Had a fairly mild attack. Bubo suppurated.

Residence.—A large two-storied brick building, being part of the main railway station for the city. Patient slept in a small room off the kitchen attached to the refreshment-room portion of the building. No stables. A number of fowls kept on the premises. Connected to sewer. Bedroom disinfected 27th May, 1905.

Employment.—As above. Wooden floors throughout the building. The yard was covered with a thin layer of asphalt in defective state of repair.

Rats.—At residence and employment. One plague-infected rat taken on 6th May, 1905. The premises are distant about 50 yards from the wharves, and separated from them by the railway tracks. A large 4 feet by 4 feet sewer, square in section, with the sides and bottom formed of loosely set rubble, runs along the centre of the footway by the side of the building, and into it the drains from the patient's residence and place of employment fall. This sewer discharges open-mouthed under the wharf almost immediately opposite, and distant about 50 yards from the railway station. Six plague-infected rats were taken at this wharf at intervals between 6th April, 1905, and 30th June, 1905. The yard of the premises at which the patient was employed, and neighbouring offices placed near the sewer referred to above, were reported to have been infested with rats, and on examination the yard and ground bordering this sewer were found to be honeycombed by rat runs.

Contacts and further Cases.—At residence and employment, 8. No further cases occurred.

CASE L.

Summary.—G.St.C.W., m., æt. 48, unmarried. No previous attack; not inoculated; no communication with any previous case. Notified by the Resident Medical Officer, Newcastle Hospital, at 10 a.m. 30th May, 1905; visited by me, 11 a.m., 30th May, 1905. Admitted to Newcastle Hospital, 29th May, 1905; discharged cured, 18th July, 1905; duration of illness, 51 days. Resided at 96, King-street, Newcastle, and employed as jobbing carpenter about the city. Left axillary bubo; morphological and cultural tests positive.

Movements prior to Attack.—Employed during the past ten days as carpenter at 299, Hunter-street West, Newcastle; frequented the wharves and other parts of the town when off work; last at work, 29th May, 1905.

History of Illness.—At 4 p.m., 29th May, 1905, whilst engaged doing some carpentering work on the premises mentioned above, was attacked by severe rigor and felt pain in the left armpit. Had to leave off work, and betook himself to his lodgings at 96, King-street, where he lay down for a few hours and was then conveyed to the Newcastle Hospital. When seen in hospital he was in a more or less stupid condition, with dusky complexion, tongue dry, with brownish fur. In left axilla a large, soft, and tender gland the size of a large walnut. T., 103·5; P., 120. No lesions apparent on the drainage area of the bubo. He passed through a severe attack of the disease; violent delirium for several days. Bubo broke down and took a long time to heal up. Received 580 c.c. Yersin's serum during the course of his illness.

Residence.—He lodged with a family occupying one of a row of three small weatherboard cottages, in fair repair, and generally clean; connected to sewer; pail closet; large stables on the adjoining premises, at the rear of the cottage. Disinfected, 31st May, 1905.

Employment.—During ten days prior to attack employed at small athletic ground fronting Hunter-street West, Newcastle; shops and dwellings on two sides of it, open land at the rear.

Rats.—At residence, several rat-holes in floors of skillion part of the premises. On the stable premises, at the rear of the dwelling, 1 plague-infected rat was taken on 5th May, 1905, and on premises adjoining these, 17 plague-infected rats were found on dates between 2nd May, 1905, and 22nd May, 1905. At employment, no traces.

Contacts and further Cases.—At residence, 3; at employment, 4. No further cases occurred.

CASE M.

Summary.—H.J., m., æt. 17, unmarried. No previous attack; not inoculated; no communication with any previous case. Notified by the Resident Medical Officer, Newcastle Hospital, 9 a.m., 4th June, 1905; visited by me, 10 a.m., 4th June, 1905; admitted to Newcastle Hospital, 3rd June, 1905; discharged cured, 27th June, 1905; duration of illness, 29 days. Right inguinal bubo; morphological and cultural tests positive. Resided with his parents at Macquarie-street, Merewether, a suburb of Newcastle, and worked as stable boy at a large colliery off Darby-street, Newcastle.

Movements prior to Attack.—Employed each day regularly as stable boy at the colliery for several months past. Walked from his home to his work every morning, a distance of about 1½ miles, and returned direct home every night after finishing his work. Last at work, 29th May, 1905.

History of Illness.—On getting up at 4 a.m., 30th May, 1905, to proceed to his work, he felt giddy, and fell down; took to bed, where he remained. Headache set in, and pain in right groin. Seen by a medical man on 31st May, 1905, on which date T. 101. There was then present a slightly enlarged and tender gland in the right inguinal region. The case was not notified, however, until 3rd June, 1905, at 7·30 p.m. On admission to hospital, 3rd June, 1905, T., 104; P., 120; right inguinal bubo size of unshelled almond, firm, and tender to touch; slight periadenitic thickening. No lesions noticeable on drainage area of bubo. Case ran a mild course; gland did not break down.

Residence.—

Residence.—A weatherboard cottage, situated on elevated ground in Macquarie-street, Merewether, about 1½ miles from Newcastle, in good repair and clean ; no drains ; pail closet ; no stables on or near the premises. Bedroom disinfected, 5th June, 1905.

Employment.—As stable boy at a colliery, off Darby-street, Newcastle, where there were forty horses employed in and about the mine. These horses were stalled and fed in two long rows of stables near the pit top. There was a detached feed-room near the stables. The patient and another employee fed and groomed these horses daily. Stalls with stone floors ; feed-room wooden floor, elevated about 6 inches off the ground ; premises generally clean.

Rats.—At residence, no signs. At employment, the putrid carcases of 2 rats were found in the feed-room at the colliery where the patient worked. The feed (chaff, hay, maize, &c.) stored in this room was brought every day or two from a produce store on the wharf belonging to the same company which owned the colliery. Nine plague-infected rats were taken at this wharf between 17th April, 1905, and 13th May, 1905. On overhauling the produce store on this wharf on 7th June, 1905, several putrid and desiccated carcases of rats were discovered.

Contacts and further Cases.—At residence, 11 ; at employment, 1. No further cases occurred amongst these persons.

CASE N.

Summary.—J.J.McD., m., æt. 15, unmarried. No previous attack ; not inoculated. Notified by Dr. E. J. S. Spark at 3 p.m., 3rd July, 1905 ; visited by me, 5 p.m., 3rd July, 1905. Admitted to Newcastle Hospital, 3rd July, 1905 ; discharged cured, 1st August, 1905 ; duration of illness, 31 days. Resided with parents at Stockton, a suburb of Newcastle, situated on the north side of the harbour, and employed at a large biscuit factory in Melville-street, Newcastle, carrying trays and baskets in connection with a biscuit-baking oven, and also at a mixing machine in a small room in the office part of the works. Left inguinal bubo ; morphological and cultural tests positive.

Movements prior to Attack.—Worked regularly during several months past at the biscuit factory, at which there were employed about 700 hands, male and female. Travelled by ferry from Stockton each morning, and returned home each evening after leaving work. He took his lunch to the factory, and ate it on some vacant land just outside the works. Last at work, to 1 p.m. 1st July, 1905.

History of Illness.—At 11 a.m. 2nd July, 1905, had an attack of vomiting and shivering ; about an hour later felt sharp pain in left groin ; took to bed, where he remained till removed to the Newcastle Hospital by ambulance on 3rd July, 1905. On admission, was in a delirious condition ; temperature, 104 ; pulse, 96 ; bubo left inguinal region, size of large walnut, tense and tender ; body very dirty, numerous flea-bites on body and limbs. Attack severe, delirium for several days ; bubo broke down. Received 380 c.c. Yersin's serum during course of illness.

Residence.—A detached weather board cottage in poor repair and unclean condition ; no stables, but fowl-houses and a quantity of lumber in the yard ; no drains ; pail closet. Disinfected 4th July, 1905.

Employment.—A large and substantially-built brick structure in good repair, connected to sewer ; stables at rear of main buildings.

Rats.—At residence, 8 rodents trapped on the premises were all found to be healthy. No evidence of plague infection had at any time been discovered amongst the large number of rats and mice taken in the municipality of Stockton, where the patient's residence was situated. At employment, as in Case C as regards the main buildings. In the small mixing-room, situated in the office part of the premises, where the patient was employed for about one hour a day, there were many rats' holes in the skirtings, floors, and plaster walls, but no plague-infected rats were found on the premises, and no carcases were discovered. It was stated by the patient that he had seen several rats in this small room a week or two before he fell ill. Attempts were made to secure rats on these premises, but without success. At the ferry-landing on the Newcastle side, which the patient frequented, 12 plague-infected rats were taken between 2nd April, 1905, and 6th July, 1905.

Contacts and further Cases.—At residence, 11 ; at employment (in that part of the building where the patient spent most of his time), 40 ; in the small mixing-room, 1. No further cases occurred amongst any of these persons.

PROGRESS OF THE EPIDEMIC.

15. The following table shows the number of notifications and number of deaths each week :—

Week ending—	Notifications.	Deaths.	Week ending—	Notifications.	Deaths.
April 1	3	1	May 27	3	...
,, 8	1	...	June 3	...	...
,, 15	...	...	,, 10	1	...
,, 22	...	...	,, 17	...	...
,, 29	1	1	,, 24	...	...
May 6	3	1	July 1	...	...
,, 13	1	...	,, 8	1	...
,, 20	..	...			
				14	3

CASES REPORTED FOR DIAGNOSIS.

16. Between 25th March and 12th July, 13 cases were reported to me for diagnosis, but all turned out not to be plague. One of these, a female, æt. 16, who died suddenly after a few days' illness, furnished good grounds for suspicion, but the *post mortem* examination disproved this.

CLINICAL FORMS.

17. In 13 of the 14 cases, buboes were present; the remaining case was septicæmic in type. The buboes were situated in the following regions:—Right inguinal, 4; left inguinal, 1; right femoral, 1; left femoral, 5; left axillary, 2. In each case a single gland was involved.

MODE OF ONSET.

18. This was sudden in every one of the 14 cases. The patient could definitely state the time of the onset of his first symptoms. These in 7 instances consisted of headache associated with shivering, in 7 there was vomiting, and in almost all cases, within a few hours after the onset of these symptoms, and often accompanying them, pain was experienced in that glandular region which subsequently presented a definite bubo.

SEX INCIDENCE.

19. All the 14 patients were males.

AGE INCIDENCE.

20. Seven cases were at age period 15–20, 3 at period 20–30, 1 at period 30–40, and 3 at period 40–50 years.

FATALITY.

21. Of the 14 cases, 3 proved fatal. The ages of the fatal cases were 16, 17, and 44 years respectively. The fatality rate of the 14 cases was 21·4 per cent. Of the fatal cases, 2 were bubonic and 1 septicæmic. One death occurred 8 days after the onset of illness, and 5 days after coming under treatment in hospital; the second death (septicæmic plague) occurred on the fifth day after the patient fell ill; and the third death occurred 3 days after attack, and 2 days after admission to hospital.

SERUM TREATMENT.

22. Yersin's anti-pest serum was used in the treatment of 10 of the 14 cases. It was given subcutaneously in all instances. The quantity injected in individual cases varied considerably, the amount and frequency of dosage being determined by the gravity of the case. The maximum amount used in any case was 944 c.c., and the minimum, 50 c.c. Urticarial eruptions and joint pains followed the use of the serum, and were very marked in those cases where the dosage was high. The number of cases are far too few to enable a correct judgment to be formed, but the serum treatment appeared to be of considerable value, and in the 2 cases with axillary buboes, both very severe attacks, it probably helped very largely in averting a fatal issue.

RELATION BETWEEN SUCCESSIVE CASES.

23. The following facts were ascertained:—

Case B lived on premises adjoining and in direct communication with those at which Case A worked, and where A is credited with having received his infection, but B did not know A, nor did he visit the premises at which A worked.

Case C worked at the same factory as Case N (date of attack of C, 28th March, 1905; that of N, 2nd July, 1905), but they were employed in different parts of this establishment, which is a very large one, employing about 700 hands, and they were not associates, nor did they know each other, except by sight.

Case D lived in the same part of the city as Cases A and C (their residences being separated from each other by about 200 yards), but he did not associate with either of them, nor visit their residences.

Case E worked at the same produce store as case A, but in a separate, detached part of it (date of attack of A, 22nd March, 1905; that of E, 22nd April, 1905. They were known to each other, but were not associates, nor did they visit each other's homes.

Case F performed the *post mortem* examination on Case E, and was inoculated through a small abrasion of the left forefinger, made during the *post mortem*.

Case G (date of attack, 3rd May, 1905) worked at stables in a yard adjoining, and had to pass through part of the same premises where Cases H (date of attack, 5th May, 1905) and I (date of attack, 11th May, 1905) were employed. He did not associate with either of them.

Cases H and I (date of attack of H, 5th May, 1905; that of I, 11th May, 1905) were employed on the same premises, and ceased work on the dates on which they were attacked. They did not associate together, nor visit each other's homes.

Cases J, K, L, and M were not known to each other, or to any of the other cases, nor did they frequent the same premises.

24. It amounts to this, then, that on one premises, employing 35 persons, 2 cases occurred, with an interval of four weeks and three days between the two cases. At a second premises, 2 cases occurred amongst the 700 hands employed, with an interval of fourteen weeks between the cases. At a third premises, employing 9 persons, 2 cases occurred, with an interval of six days between the cases. In these, as well as in the remaining 7 cases (Case F excluded), there was no evidence to support the view that the infection was conveyed from one person to the other. As will be seen later on, the outstanding factor common to the whole of the 13 cases was the association of plague-infected rats at their residence or place of employment.

PLAGUE IN RATS IN RELATION TO THE EPIDEMIC.

25. On the discovery of the first case of plague in man, steps were taken to provide for the destruction of rats in the city and district. A staff of four experienced rat-catchers sent by the Department of Public Health was employed to procure rats for examination from all parts of the city. At the same time the municipal local authority notified the general public, by handbills and posters throughout the city and district, of the necessity of taking steps to destroy rats about their premises. The rat incinerator in Merewether-street was started, and a bonus of 3d. per rat and 1d. per mouse was paid for all rodents brought to the incinerator.

26. Between 28th March and 14th August, 1905 (the dates of the opening and closing of the incinerator, respectively), 13,901 rodents were destroyed. Of this total, 12,191 were rats and 1,710 mice. Of the total, 2,391 were procured by the rat staff, consisting of four men.

27. Of the 13,901 rodents brought to the incinerator, 6,653 (including the 2,391 procured by the staff) were examined for plague, and 206 of them were definitely proved to be infected with the disease. It should be stated that a large number of the rodents brought for examination were too far advanced in decomposition to enable a definite decision to be formed as to the cause of their death, though it was in all probability due to plague, for it not infrequently happened that one or more of a batch found on the same premises were plague infected, whilst the remainder were too decomposed to allow of a prompt and definite decision being arrived at, though the indications pointed to plague having been the cause of their death. Leaving this out of account, however, it is still found that 3 per cent. (206 out of 6,653) of the rodents examined were plague infected. This is a considerably higher proportion than has hitherto been found in this State.

28. The percentage of the several species amongst the total (6,653) rodents examined during the period 28th March to 14th August, 1905, was—*Mus musculus*, 11·1 per cent.; *Mus rattus*, 22·2 per cent.; and *Mus decumanus*, 66·7 per cent.

29. Of the 206 plague-infected rodents, 171 were *Mus decumanus*, 22 *Mus musculus*, and 13 *Mus rattus*. They thus respectively constituted 83, 10·6, and 6·3 per cent. of the total found infected.

30. The last case of plague in the epidemic was notified on 4th July (date of attack, 2nd July); the last plague-infected rat was taken on 6th July. Between 6th July and 14th August, when the incinerator was closed, 594 rats from different parts of the city were examined, but they were all found to be healthy.

31. There was no evidence that ordinary domestic animals suffered from the disease. Five domestic cats in a sickly condition were submitted for examination, but they were all found not to be suffering from plague.

32. The different species of plague-infected rats found at the credited place of infection of the 13 plague cases are set out in the following table (Dr. J.R.L., Case F, is omitted) :—

Credited place of infection.	Species of infected rodents found at such credited place of infection.
	Case A.
Employment (produce store).	M. *decumanus*, M. *musculus*
	Case B.
Residence	Putrid rodents only. Premises adjoined and in direct communication with those on which Case A worked.
	Case C.
Residence	M. *decumanus*.
	Case D.
Employment (marine store).	M. *decumanus*.
	Case E.
Employment (produce store).	*M. decumanus*, M. *musculus*.
	Case G.
Employment (stables).	M. *decumanus*.
	Case H.
Employment (butcher's shop).	M. *decumanus*.
	Case I.
Employment (butcher's shop and stables).	M. *decumanus*.
	Case J.
Employment (grocery store).	M. *decumanus*, M. *rattus*, M *musculus*.
	Case K.
Employment (restaurant).	M. *decumanus*.
	Case L.
Residence	No rodents on premises, but M. *decumanus* in stables at rear.
	Case M.
Employment (stables).	M. *decumanus*.
	Case N.
Not determined ...	None at residence or employment. M. *decumanus* at ferry wharf frequented by patient.

33. Thus, where plague-infected rodents were found on the credited places of infection, *Mus. decumanus* was the species concerned in each instance, *M. musculus* in association with it in three instances, and *M. rattus* in association with *M. decumanus* and *M. musculus* in one instance.

34. The following table shows the number of rodents examined week by week from the beginning of the epidemic down to 14th August, together with the percentage of rats found plague-infected amongst those examined :—

Week ending—	Rodents examined.	Plague infected.		Human cases notified.	Week ending—	Rodents examined.	Plague infected.		Human cases notified.
		Number.	Percentage.				Number.	Percentage.	
April 1 ...	300	10	3·3	3	June 24 ...	209	...	......	...
„ 8 ...	310	14	4·5	1	July 1 ...	163	1	·61	...
„ 15 ...	275	4	1·4	...	„ 8 ...	245	2	·81	1
„ 22 ...	314	17	5·4	...	„ 15 ...	143	0	......	...
„ 29 ...	279	9	3·2	1	„ 22 ...	78	0	......	...
May 6 ...	646	23	3·5	3	„ 29 ...	118	0	......	...
„ 13 ...	664	20	3·0	1	Aug. 5 ...	122	0	......	...
„ 20 ...	616	42	6·8	...	„ 12 ...	44	0	......	...
„ 27 ...	729	33	4·5	3	„ *19 ...	33	0	......	...
June 3 ...	518	22	4·2	...					
„ 10 ...	393	2	·50	1	Totals ...	6,653	206	3·0	14
„ 17 ...	454	7	1·5	...					

* Incinerator closed 14th August.

35. Though more than 2,500 rats caught in the suburbs of Newcastle were examined, only 5 were found to be infected with plague. The circumstances surrounding these rats deserve mention, as they were the only plague-infected rodents discovered outside the boundaries of the City of Newcastle. Four of these ats were taken from a garbage tip in the municipality of Wickham. This tip is located on the foreshores of a creek which discharges into the harbour at a point distant about 1½ miles from the city boundaries. The sources of infection in this locality may be explained in this way :—Two cartloads of refuse from the butcher's shop in Hunter-street West, Newcastle, at which Cases H and I worked, and where

many plague-infected rats were taken, were carted surreptitiously at the dead of night by some of the employees of this firm, and deposited at this tip. (The culprits were seen doing this, were prosecuted, convicted, and fined £4, the maximum penalty allowed by the by-law under which the proceedings were taken, or two months' gaol.) This happened on 6th May, 1905; 4 plague-infected rats were discovered at this tip between 12th June, 1905, and 15th June, 1905.

36. In the only other instance where plague-infected rats were found outside the Newcastle boundary occurred in the feed-room attached to a stable in Wickham. It was ascertained that about fifty bags of chaff had been received from the produce store connected with the merchant's premises in Bond-street, Newcastle, at which plague-infected rats were discovered on 9th May, 1905. One plague-infected rat was taken in the feed-room referred to on 31st May, 1905, and on overhauling the premises on 1st June, 1905, 6 other carcases of rats were discovered, but they were too putrid for examination

37. Between 28th March and 6th July, 162 of the total 206 plague-infected rats were taken from 49 premises, and of the remainder, 41 came from the foreshores and under the wharves lining the harbour, and 3 from an open sewer in Cook's Hill. Infected rats were discovered along the wharves as early as 2nd April, and the last plague-infected rodent taken, namely, on 6th July, came from the same locality.

38. Of the 49 premises on which plague rats were found, 15 stables yielded 37 rats; 8 produce stores yielded 37 plague rats; 2 fish shops, 23 rats; 1 photographer's, 19 rats; 2 bakers, 10; 4 hotels, 11; 1 butcher's, 4; 1 marine store, 2; 2 ship-chandlers, 2; 3 restaurants, 3; whilst 10 premises in private occupation yielded, 14 plague rats. The 10 premises last mentioned were situated in close proximity to, and in many cases abutted on, produce stores, stables, or one or other of the business premises referred to above, and it seems most likely that the infected rats found on them were members of the company infesting the neighbouring premises.

39. Consideration of the subject of plague in rats, and its relation to plague in man, shows on the one hand that at 41 different premises in the city (excluding the wharves) which yielded plague rats, no cases of plague occurred amongst the occupants or employees of any of these premises. A premises may apparently be grossly infested by plague rats, and yet no case occur amongst the inmates of those premises. A striking instance of this is furnished in the case of three adjoining premises in Hunter-street. In the cellars of a fish shop, a hotel, and a photographer's premises adjoining one another, no less than 43 plague-infected rats and a number of putrid carcases of rats were discovered between the 15th May, 1905, and 2nd June, 1905, during cleansing operations, but no case of plague preceded, accompanied, or followed amongst the inmates of any of these premises. On the other hand, in the 13 cases of plague (Case F excluded), infected rats were discovered at the residence or place of employment of 11 out of the 13 cases. As regards the remaining 2 cases, plague-infected rats to the number of 14 were taken between the 2nd May, 1905, and 22nd May, 1905, on stable and other premises immediately at the rear of the residence of one of them (Case L, date of attack, 29th May, 1905), whilst in the remaining case (Case N, date of attack, 2nd July, 1905) no plague-infected rats were found either at his residence or place of employment, but at the ferry wharf, which he frequented on the Newcastle side of the harbour, 12 plague-infected rats were taken between 2nd April, 1905, and 6th July, 1905.

40. The experiences above described coincide with those met with in plague epidemics in other parts of this State.

ORIGIN OF THE INFECTION.

41. Little consideration need be given to the question as to whether the disease was introduced into Newcastle by means of ships from plague-infected places, in other parts of the world. The ports which perhaps should be mentioned in this connection are Hong Kong, Mauritius, and those in South Africa. Now, vessels arriving in Newcastle from these places are, almost without exception, in ballast. Ships coming foreign to Newcastle, from infected ports, are subjected to fumigation with sulphur by the Port Health Officer's staff, and, as they are as a rule in ballast, this procedure can be and is carried out with great success as regards the destruction of rats. Never at any time has there been a history of plague infection in man or rats on board any ship reaching Newcastle from any foreign port.

42. Newcastle is in daily communication with Sydney by rail and sea, the trade between the two cities being very considerable by both routes. Frequent communication is maintained by sea between Newcastle and the northern ports in this State, as well as with Brisbane and other ports in the adjoining State of Queensland.

43. Epidemics of plague were experienced in Sydney during 1900 and 1902, and occasional cases occurred in 1901, 1903, and 1904; whilst plague-infected rats were found there, especially about the harbour frontages, during each succeeding year since 1900.

44. In Brisbane, Queensland, plague has not been absent since 1901.

45. The following table shows the state of affairs as regards human and rat plague in those places with which direct trade relations existed with Newcastle for the few months preceding the occurrence of the first case of plague in this city:—

Sydney. December, 1904—March, 1905.		*Northern Ports of New South Wales.* December, 1904—February, 1905.		*Brisbane, Queensland.* 2 January—9 March, 1905.	
Cases in		Cases in		Cases in	
Rats.	Man.	Rats.	Man.	Rats.	Man.
12	2	124	13	90	22

46. Now, there has been no positive evidence that plague in rats or man reached Newcastle by means of vessels trading with any of the above-mentioned places. In this connection it should be pointed out that the practice pursued by the authorities in Australasia during the past four years, so soon as plague was discovered in rats or man in any port, included the following—the fending of vessels off wharves, the provision of discs on the moorings, unloading into lighters in the stream of all fodder, the fumigation of ships' holds and other parts, when empty, by means of sulphur. These procedures had for their object the limitation, as far as possible, of the transportation of infection by means of rats.

47. But these precautions cannot be absolutely relied upon to secure freedom of infection of a clean from an infected port, for their enforcement takes place only after plague has been discovered in rats or man. Now, it has been proved over and over again, at least in Australia, that by the time the first evidence of plague is discovered in the rats of a particular place, on search being made, widespread invasion of the rat tribe is found to have already occurred, and evidence is usually not wanting to show that the infection has been in existence for a considerable time prior to the discovery of the first infected rodent. Thus many opportunities may have existed for the transportation of infection by means of rats before any steps have been taken to prevent it.

48. As bearing on the question of the possibility of the transport of infected rats and the maintenance of the infection amongst the rat tribe on board ship for several weeks, reference may be made to the case of the "Antillian s.s." (Report of the Board of Health on the Sydney Plague Outbreak, 1902, by Dr. Ashburton Thompson, pars. 50-64), where, after a voyage from Cape Town, lasting 29 days, the vessel arrived in Sydney with rats still alive and actually suffering from plague at the time of her arrival.

49. All that can be definitely stated in reference to the source of infection of the Newcastle outbreak is this: At several State and inter-State ports with which Newcastle was in direct and frequent communication by sea, as well as by land, cases of plague in rats and man existed for several months prior to the occurrence of the first case of plague in Newcastle; that produce and other goods were shipped direct from these ports to produce stores in Newcastle; that, after the notification of the first case of plague, on 25th March, search of the produce store at which the patient worked resulted in the finding of a number of plague-infected rats, and the carcases of a large number of dead and putrid rats which had apparently succumbed some weeks previously. That similar conditions, as regards rats, were met with on other premises in the city. That as soon as search was made, plague-infected rats were found about the wharves, where vessels from the places referred to in the above table lay, and infected rats continued to be taken about these wharves down to 6th July, 1905.

50. The inference drawn from these circumstances is, that the infection was transported to Newcastle, either by produce infected by means of plague rats, and conveyed from it to the local rats, or, what is much more probable, that rats were transported, and landed at Newcastle, and, in turn, communicated the disease to the local rodents, and from them it was conveyed in some, as yet imperfectly explained, manner to human beings.

51. The possibility of the transportation of infection by ambulant or unrecognised cases of human plague coming from the centres of infection in New South Wales and Queensland is so remote as not to need consideration, and may be dismissed as having no bearing on the question.

Measures taken in Suppression of the Epidemic.

52. The Assistant Medical Officer of the Government (Dr. R. J. Millard, M.B., D.P.H.) was directed to examine and confirm the diagnosis of the two first cases of the disease and to confer with me, and, later, that officer relieved me for two days on 6th and 7th May, during slight indisposition.

53. The President of the Department of Public Health (Dr. J. Ashburton Thompson) visited the city during the course of the epidemic and advised the Mayor of the city (Alderman M. J. Moroney) on important matters, which received prompt attention at his hands. At the same time the President was able to give able counsel and advice in regard to many matters in connection with the work of control of the epidemic.

54. The measures taken in the suppression of the epidemic followed in detail those so successfully employed in Sydney during the past four years, and they included the following:—

1. *As regards the patients.*—On receiving a notification of a case of plague, I visited the patient, confirmed the diagnosis (by the bacteriological methods referred to under the various cases at the beginning of the Report) and if not already in hospital, arrangements were made for his removal there by ambulance. With the exception of Case E, who died at his residence, all the patients were treated in the isolation wards of the Newcastle Hospital. The Department of Public Health sent up two trained nurses who had had previous experience in the nursing of plague patients, and they were assisted by the hospital nursing staff as occasion arose. The treatment of the patients devolved upon the honorary medical staff and resident medical officer of the hospital.
2. *Residences of patients.*—The procedure depended upon whether rodents were in evidence in and about them or not. Where the residence of the patient was deemed the place of infection (determined by finding plague-infected rodents upon them), the premises were thoroughly overhauled with the object of ridding them of rats, and were disinfected in detail. Where there was no evidence that the residence was the place of infection, then the bedroom occupied by the patient prior to his removal to the hospital was alone disinfected.
3. *Place of employment of patients.*—When deemed the place of infection, as it was in 9 of the 13 cases, the premises were thoroughly overhauled and disinfected. This, in the case of produce stores, involved a great amount of labour, and occupied considerable time. All stocks were turned over, torn and rat-eaten bag stuff destroyed, double partitions removed, wooden floors taken up, and the whole premises cleared of litter, cleansed, and disinfected. Careful search was made for rats, and active steps taken for their destruction. This detailed work of cleansing, disinfection, &c., was not confined to the particular premises on which the patient worked, but was extended so as to include all the adjoining premises which were found to be in direct communication with the infected building.
4. When plague was identified in rodents taken from any premises by the rat staff, or brought in by the public, steps were taken to overhaul, cleanse, and disinfect the premises, search for rats, &c., on the same lines as mentioned in the preceding paragraph.

5. Then followed the overhaul of successive blocks of buildings in the city, attention being given by the staff to the cleansing of premises, destruction of rats, and the removal of materials likely to harbour rats. On the plan of the city in the Appendix, the blocks which were dealt with in this way are edged with blue.
6. The rat incinerator was started in Merewether-street, Newcastle, and a bonus of 3d. per rat and 1d. per mouse was paid for all rodents brought there. The amount paid in this way was £172 16s. 4d. for 11,510 rodents. The working expenses of the incinerator from 28th March to 14th August, 1905, amounted to £42 4s. 11d.
7. A rat staff of four experienced men, detailed by the Department of Public Health, procured 2,391 rodents for examination from different parts of the city, and they did good work in the search for and destruction of rats during the overhaul and cleansing of various premises.
8. I undertook the systematic examination of rodents brought to the incinerator by the public, and those procured by the rat staff from 28th March to 2nd May inclusive. From that date down to 17th June, 1905, an assistant (Mr. G. G. Grant) from the laboratory of the Department of Public Health carried it on, then I resumed the work until 14th August, when the incinerator was closed down.
9. The City Council, by handbills and posters, urged the residents to destroy rodents about their premises. Free distribution of rat poison was made to the public. The authorities in charge of the various wharves in the district had poisoned baits systematically laid about the wharves and foreshores. The Government issued a proclamation, which was posted about the district, drawing attention to the fact that failure on the part of any person to notify to the proper authorities the fact of unusual mortality amongst rats about their premises, rendered them liable to prosecution for misdemeanour.

55. In connection with the cleansing work undertaken on the notification of the first four cases of plague, the Department of Public Health sent the Chief Sanitary Inspector (Mr. P. Getting, F.I.S.E.) to Newcastle to act under me in assisting the Sanitary Inspector of the city (Mr. T. Lloyd, Cert. R. San. Inst.) in the supervision of the work. Later on, the same Department despatched one of their experienced quarantine officers to act as ganger in charge of a number of the men performing cleansing work. The cleansing and overhaul of those portions of the city edged in blue on the map was spread over the period 28th March to 4th July, 1905.

56. The members of the Newcastle City Council are worthy of commendation for the prompt manner with which they dealt with the various matters brought under their notice, and in supplying the necessary labour and appliances requisite to enable cleansing operations to be carried out promptly and thoroughly; whilst the Mayor of the city (Alderman M. J. Moroney) is deserving of special praise for the thorough and fearless manner in which he acted on the advice and recommendations of his officers.

57. Special mention should be made of the ceaseless energy and invaluable assistance rendered by the Sanitary Inspector of the city (Mr. T. Lloyd, Cert. R. San. Inst.), whilst the Sanitary Inspector attached to my staff (Mr. J. Abberton, Cert. R. San. Inst.) and other officers rendered able service.

ROBERT DICK,
Medical Officer of Health to the Hunter River Combined Sanitary Districts.

[One Plan.]

CODE

CODE OF BY-LAWS ADOPTED BY THE NEWCASTLE MUNICIPAL COUNCIL FOR THE BETTER PREVENTION OF THE SPREAD OF PLAGUE BY MEANS OF RATS.

Published in Government Gazette No. 360, *of* 14*th July*, 1905.

Chief Secretary's Office, Sydney, 11 June, 1905.

NEWCASTLE MUNICIPALITY—BY-LAWS.

THE following By-laws made by the Council of the Borough of Newcastle, under the provisions of the "Municipalities Act, 1897," having been confirmed by His Excellency the Lieutenant-Governor, with the advice of the Executive Council, are published in accordance with the requirements of the above cited Act.

J. A. HOGUE.

Borough of Newcastle—By-laws under the provisions of the Municipalites Act, 1897.

1. The owner of any produce store, hay store, butcher's shop, bakery or pastrycook or baker's small goods bakery, or butcher's small goods shop in the municipality, the floors of which are of such material, or so constructed, or in such a state as to permit the harbouring of rats in or about such store, shall, within one month after service upon him of a notice purporting to be signed by an officer of the Council requiring him so to do, cause such floors to be so reconstructed or constructed of concrete not less than four inches in thickness, or other approved material impervious to rats, and shall so repair, alter, reconstruct or protect skirting boards, partitions, doors, ventilation, or other openings in the walls or elsewhere of such produce store, hay store, butcher's shop, bakery, or butcher's small goods shop, as to prevent, as far as practicable, access of rats to and harbourage of rats in or about it.

2. The owner of any premises within the municipality who, after the passing of these by-laws, shall construct or let any building therein for the purpose of a produce store, hay store, butcher's shop, bakery, or butcher's small goods shop, or who shall convert any building therein to the purpose of a produce store, hay store, butcher's shop, bakery, or butcher's small goods shop, shall, upon such construction, letting, or conversion, as the case may be, cause the floors thereof to be constructed of concrete not less than four inches in thickness, or other approved material impervious to rats, and he shall so construct, alter, repair, reconstruct, or protect skirting boards, partitions, doors, ventilation, or other openings in the walls or elsewhere, as to prevent, as far as practicable, access of rats to and harbourage of rats in or about such premises.

3. The owner of any building, other than a produce store, hay store, butcher's shop, bakery, or butcher's small goods shop in the municipality which is in such a condition as to permit the access of rats to, or the harbourage of rats in it, and whether such condition be in the structure, or in the openings in it, or in the doors or ways of entrance to it, or in its floors, skirting boards, ceilings, partitions, or the like internal fittings within it, shall, within one month after service upon him of a notice purporting to be signed by an officer of the Council requiring him so to do, cause such building to be so repaired, or as regards its doors or ways of entrance, and its floors, skirting boards, ceilings, partitions, and the like internal fittings within it, to be so altered or repaired as to prevent, as far as practicable, access of rats to it and harbourage of rats within it.

4. The owner or occupier of any premises within the municipality, with which is connected any area grating, or in the external walls of which is any other opening of such a nature as to permit the entry of rats thereto, shall, within fourteen days of service upon him of a notice purporting to be signed by an officer of the Council requiring him so to do, cause such area grating and such other openings to be covered with wire netting of such a mesh, and in such a manner, as to prevent the entry of rats through them.

5. The owner or occupier of any stable, cow-yard, cattle-shed, piggery, or pig-shed within the municipality now constructed, shall cause to be paved, flagged, or floored with concrete not less than four inches in thickness, or other approved material impervious to rats, and to be completely and well drained, and to have proper sewer connections where available, within one month after service upon him of a notice purporting to be signed by an officer of the Council requiring him so to do.

6. The occupier of such premises shall, upon production of the notice served upon the owner as aforesaid, allow the owner and his workmen free access thereto, for the purpose of enabling him and them to comply with the terms of the preceding by-laws.

7. The owner or occupier of any premises within the municipality who shall, after the passing of these by-laws, construct a stable, cow-yard, cattle-shed, or pigsty therein, or convert any building therein into a stable, cow-yard, cattle-shed, or pigsty, shall cause the same to be paved or floored with concrete not less than four inches in thickness, or other approved material impervious to rats, to be completely and well drained, and to have proper sewer connections where available.

8. The owner or occupier of any stable, cow-yard, cattle-shed, or pigsty within the municipality shall, within one month of the service upon him of a notice purporting to be signed by an officer of the Council requiring him so to do, cause any feed store connected with such stable, cow-yard, cattle-shed, or pigsty to be floored with concrete not less than four inches in thickness, or other approved material impervious to rats, and shall so reconstruct, repair, or alter any floor, wall, and any ceiling or partition within it, as may be directed, so as to prevent the harbourage of rats therein, and shall protect all openings in the external walls thereof, as may be directed, so as to prevent the access of rats thereto.

9. The occupier of any premises in the municipality which contain any stable, cow-yard, cattle-shed, or pigsty shall provide a bin for the reception of all dung or refuse arising in such stable, cow-yard, cattle-shed, or pigsty, built of brick or other impervious material; if of brick, must be not less than 4½ inches brickwork floated on all internal parts, with at least half an inch good clean cement, and shall cause such stable, cow-yard, cattle-shed, or pigsty to be cleansed daily; and all manure, dung, or other refuse arising in or in connection therewith, if not removed from the premises immediately, to be placed in such bin, and shall cause the said bin to be kept covered, and to be emptied and cleansed, and its contents to be removed from the premises, at least *once* every week, or oftener if necessary, and shall not at any time allow such bin to be or to remain a nuisance.

10. No person shall place or throw, or suffer to remain, any refuse on any premises in the municipality in such a manner or for such a time as to encourage rats or other vermin to visit or frequent such premises.

11. Every occupier of premises in the municipality shall, within seven days of service upon him of a notice purporting to be signed by an officer of the Council requiring him so to do, provide a sufficient number of receptacles of rigid metal, cylindrical in shape, and provided with two side handles, and each of a capacity not exceeding 2 cubic feet, for the reception of the garbage and refuse arising upon such premises.

12. Every such occupier shall provide all refuse and garbage receptacles in use on such premises with a cover fitting as closely as practicable.

13. Every such occupier shall cause such receptacles to be continuously covered, save when garbage or refuse is being deposited in or discharged from them.

14. Every such occupier shall cause all refuse or garbage receptacles in use on his premises, and the covers thereof, to be kept as clean as practicable, and maintained in good order and condition.

15. Every such occupier shall cause all garbage and refuse from time to time arising from such premises to be forthwith deposited in such receptacle.

16. Every such occupier, between such hours and such days as may be prescribed by the notice served upon him, and purporting to be signed by an officer of the Council, shall cause such receptacles to be placed in such a position on such premises as to be within six feet of the gateway or entrance from the street abutting on such premises, which is traversed by any vehicle employed by the Council in the collection of garbage and refuse, and so as to be conveniently accessible to the persons employed by the Council in the collection and removal of garbage and refuse. Provided that, if by reason of conformation of the premises, it shall not be practicable to comply with the requirements of this by-law, and such occupier shall cause such receptacles to be placed on the outer edge of the footway in such street between the hours and days as aforesaid, he shall not be guilty of any offence against this by-law.

17. No person other than a workman employed by the Council in the collection of garbage and in street cleansing shall interfere with, disturb, or remove any garbage receptacles for the time being in any street, nor the contents of any such receptacle.

18. The owner of any premises within the municipality shall, within one month of service of a written notice purporting to be signed by an officer of the Council, cause the floor of any water-closet and of any pail closet, situated wholly or in part outside the walls of the dwelling portion of the premises, to be constructed of good cement concrete not less than four inches in thickness, and to be so laid that it shall be in every part thereof at a height of not less than six inches above the level of the ground adjoining such closet, and so that the said floor may have a fall or inclination from the rear of the closet towards the door of entrance of not less than one half-inch to the foot, and the riser enclosing the space beneath the seat (if any) to be removed in the case of a water-closet, and in the case of a pail closet, to be well-fitted to the seat, and to extend downwards not more than four inches from the underside of the seat.

19. In construction of these by-laws, the words "produce store" shall mean any building, or portion of a building, wherein wheat, oats, barley, maize, pollard, bran, hay, lucerne, chaff, flour, or vegetables is deposited or kept exposed for sale, and with regard to other words a similar construction shall be applied as the Interpretation Act No. 4, 1897, provides for the interpretation of Acts of Parliament.

Definition of Owner.

20. In the construction of these by-laws, the word "owner" shall mean the person for the time being receiving the rent of the premises in connection with which the word is used, whether on his own account, or as agent or trustee for any other person, or who would receive the same if such premises were let at a rent.

21. Any person offending against any of the above by-laws shall for each offence upon conviction forfeit and pay a sum not exceeding ten pounds, and shall be further liable to a penalty of one pound for each and every day the offence is continued after notice, provided that no penalty or penalties shall exceed fifty pounds.

Made and passed by the Council of the Borough of Newcastle, this twelfth day of June, in the year of our Lord one thousand nine hundred and five.

(L.S.) M. J. MORONEY,
Mayor.

E. Scott Holland,
Town Clerk.

APPENDIX A.

MAP

OF THE

CITY OF NEWCASTLE

AND

ADJACENT MUNICIPALITIES

(Prepared for the Department of Public Health),

Showing places at which plague rats were taken during 1905, the places at which persons who had plague were employed, and the places at which they resided.

EXPLANATORY NOTES.

Places at which plague rats were taken in consecutive order shown thus ●1

Places at which persons who had plague were employed " A

Places at which persons who had plague resided " ⓐ

TABLE showing places at which, and the first and last dates on which plague rats were taken, together with the order of attacks of the fourteen cases:—

No.	Place.	Rodents taken.				First.	Last.
		Total.	M. Dec.	M. Rat.	M. Mus.		
	CASE A.—Attacked, 22-3-5.						
	CASE B.—Attacked, 25-3-5.						
	CASE C.—Attacked, 28-3-5.						
1	183, Hunter-street	4	3	...	1	28-3-5	2-4-5
	CASE D.—Attacked, 31-3-5.						
2	128, King-street	5	5	...	...	1-4-5	2-4-5
3	Produce store, Crown-street	2	1	...	1	2-4-5	6-4-5
4	Market Wharf	12	12	...	...	2-4-5	6-7-5
5	168½, Darby-street	1	1	...	...	2-4-5	2-4-5
6	202, Darby-street	1	1	...	...	2-4-5	2-4-5
7	130, King-street	1	1	...	...	3-4-5	3-4-5
8	91, Dawson-street	2	2	...	...	5-4-5	6-4-5
9	113, King-street	1	1	...	...	5-4-5	5-4-5
10	N. and H. R. wharf	6	6	...	...	6-4-5	30-6-5
11	Parry-street sewer	3	3	...	...	7-4-5	18-5-5
12	131, Scott-street	1	1	...	...	8-4-5	8-4-5
13	27, Dawson-street	1	1	...	...	10-4-5	10-4-5
14	37, Scott-street	1	1	...	...	13-4-5	13-4-5
15	A. A. Co.'s wharf	7	6	1	...	17-4-5	13-5-5
16	Railway yard	1	1	...	...	17-4-5	17-4-5
17	123, Scott-street	1	1	...	...	17-4-5	17-4-5
18	Carrington Bridge foreshore	6	6	...	...	18-4-5	25-4-5
19	59, Hunter-street West	3	3	...	...	18-4-5	20-4-5
20	199, Hunter-street West	1	1	...	...	20-4-5	20-4-5
	CASE E.—Attacked, 21-4-5.						
21	157, Hunter-street West	2	2	...	...	22-4-5	26-4-5
22	121, Hunter-street	3	3	...	...	25-4-5	27-4-5
23	203-205, Hunter-street West	4	4	...	...	25-4-5	1-5-5
24	Timber wharf	4	4	...	...	27-4-5	12-5-5
	CASE F.—Attacked, 29-4-5.						
25	9, Burwood-street	1	1	...	...	1-5-5	1-5-5
26	Off Wolfe-street	4	4	...	...	1-5-5	1-5-5
27	17, Perkin-street	1	1	...	...	2-5-5	2-5-5
28	1, Bond-street	9	1	6	2	2-5-5	25-5-5
	CASE G.—Attacked, 3-5-5.						
29	109, Hunter-street	8	8	...	...	4-5-5	8-5-5
30	58, Scott-street	11	7	1	3	4-5-5	27-5-5
	CASE H.—Attacked, 5-5-5.						
31	193, Hunter-street West	2	2	...	...	5-5-5	5-5-5
32	116, Darby-street	1	1	...	...	5-5-5	5-5-5
33	8, Wolfe-street	1	1	...	...	5-5-5	5-5-5
34	Merewether-street foreshore	1	1	...	...	5-5-5	5-5-5
35	Railway Station, Scott-street	1	1	...	...	6-5-5	6-5-5
36	333, Hunter-street West	3	1	1	1	9-5-5	29-5-5
	CASE I.—Attacked, 11-5-5.						
37	51, Hunter-street	1	...	1	...	11-5-5	11-5-5
38	32, off Church-street West	1	1	...	...	12-5-5	12-5-5
39	167, Hunter-street West	2	2	...	...	12-5-5	14-5-5
40	81-83, Hunter-street West	3	3	...	...	12-5-5	14-5-5
41	58, Hunter-street	19	19	...	...	15-5-5	24-5-5
42	17, Telford-street	6	...	...	6	15-5-5	30-5-5
43	54, Hunter-street	4	4	...	...	16-5-5	30-5-5
44	323, Hunter-street West	6	6	...	...	17-5-5	18-5-5
45	48, Sidney-street	1	...	...	1	17-5-5	17-5-5
46	133, Hunter-street	2	2	...	...	17-5-5	17-5-5
47	56, Hunter-street	20	20	...	...	17-5-5	2-6-5
	CASE J.—Attacked, 19-5-5.						
48	9, Wolfe-street	1	1	...	...	20-5-5	20-5-5
49	5, Perkin-street	1	1	...	...	22-5-5	22-5-5
50	321, Hunter-street West	10	7	...	3	23-5-5	25-5-5
51	125, Hunter-street West	1	1	...	...	24-5-5	24-5-5
	CASE K.—Attacked, 26-5-5.						
	CASE L.—Attacked, 29-5-5.						
	CASE M.—Attacked, 30-5-5.						
52	Stables, Maitland-road	1	1	...	...	31-5-5	31-5-5
53	Stables, Bond-street	2	...	2	...	1-6-5	1-6-5
54	275, Hunter-street West	1	...	1	...	1-6-5	1-6-5
55	Tip, Throsby Creek, Smedmore	4	3	...	1	12-6-5	15-6-5
56	Stables, A. A. Co.'s wharf	2	...	...	2	16-6-5	16-6-5
57	9, off Wolfe-street	1	...	...	1	17-6-5	17-6-5
	CASE N.—Attacked, 2-7-5.						
58	135, Scott-street	1	1	...	...	6-7-5	6-7-5
	Totals	206	171	13	22	......	......

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Seamen's Hospital Society
TROPICAL DISEASES
19 JUN. 1923
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APPENDIX A.

The following are the more important of the forms which have been used in connection with the investigation of Plague :—

No. 1. Form No. 317.

DEPARTMENT OF PUBLIC HEALTH, N.S.W.

Plague. **Visiting Medical Officer's Report.** **Case No.**

Notified by on 19 , at m.
Visited by on 19 , at m.
Diagnosis (1) Plague. Clinical form

Name Age , Sex , condition
Residence
Employment, place of
Nature of
Last attendance at
Where found
Reported for removal to Hospital on at m.
Clinical account. Illness began on at m.,
and had a (2) onset. First symptom
History previous to examination :—

Bubo of region, first noticed on
19 , at .m. Progress
Condition on examination. T. P. R.
Bubo
Specimen taken . Result of Smears
Lesions of drainage area of Bubo
Previous attacks at on 19 .
Previously inoculated at on 19 .
Present inoculation, Haffkine fluid ccm, on 19 .
serum, ccm, on 19 .
Relation to previous patients
Relation to infected articles
Relation to Dead or Sick rats
Movements for 10 days previous to attack
Contacts—
At Residence

Name.	Inoculated (Date.)	Haffkine (Quantity.)	Serum (Quantity.)

At employment as by list attached.
Illness amongst
Plague amongst

Form

---

[1] If necessary insert "not."

[2] Insert sudde or gradual.

No. 2. Form No. 320.

DEPARTMENT OF PUBLIC HEALTH, N.S.W.

Coast Hospital.

Plague. **Case No.**

[1] Severe, moderate, mild.

Diagnosis Clinical form Type (1)
Name age, sex condition
Residence
Employment, place of
Nature of
Last attendance at
Admitted on 19 at m., Ward

[2] Discharged or died.

D (2) on 19 at m., Total illness days
Previous History
History of Present Illness. Began on 19 at m.

[3] Sudden or gradual.

[4] Onset symptoms, headache, vertigo, malaise, nausea, vomiting, weariness, aching, pain, rigor, prostration, hebetude, delirium, coma.

Onset (3), First noticed
After that (4)
Bubo of region, first noticed on
as
Relation to previous cases
Relation to infected articles
Relation to dead and sick rats
Relation to fleas
Movements for 10 days previous to attack
Previous attacks at on
Inoculation at on 19

State on Admission.

On admission. T P R

General Condition—
Prostration.
Position in bed.
Aspect.
Expression.
Pallor, flush.
Eyes.
Nervous System—
Apathy.
Hebetude.
Coma.
Sleep.
Restlessness.
Delirium.
Speech.
Circulatory System—
Heart.
Pulse.
Respiratory System—
Lungs.
Cough.
Expectoration.
Alimentary System—
Thirst.
Appetite.
Tongue.
Vomiting.
Bowels.
Urinary System—
Cutaneous System
Skin generally.
Rashes.
Bubo—
Site.
Size.
Tenderness.
Consistence.
Colour.
Pain.
Periadenitis.
Cutaneous lesions within drainage area of primary bubo.

SUBSEQUENT PROGRESS. (See also T Chart and Bed Card.)

Microbiological Laboratory. Forms of Record.

No. 3.

EXAMINATION OF RATS.

Consecutive No.	Date.	Source.	Species.	Condition.	Result.	Remarks.

No. 4.

DIAGNOSTIC EXAMINATIONS FOR PLAGUE.

No.	Date.	Patient's Name.	Residence.	Place of Employment.	Specimen.	Submitted by	Result of Examination.			Diagnosis.	Remarks.
							Smears.	Cultures.	Inoculation.		

No. 5.

MICROBIOLOGIST'S REPORT FORM.

Microbiological Laboratory, , 190 .

Plague, 1906.

Sir,

I have the honor to report the following result of my examination of

Submitted by

and received at this Laboratory for examination on

Result of examination.

Smear preparations :—

Culture :—

Inoculation :—

I have the honor to be,
Sir,
Your obedient servant,

Principal Assistant Medical Officer of the Government.

The Chief Medical Officer.

No. 6. Form No. 318.

DEPARTMENT OF PUBLIC HEALTH, N.S.W

Plague Sanitary Inspector's Report. Case (1)

Name of Patient

Residence at

Kind of house (2) of (3) storey rooms (4)

Situation (5) built of in repair

Cleanliness lighting ventilation

If connected with sewers

Outhouses

Trade carried on

Sanitary state

Signs of (6) rat infestation, consisting of

Vicinity, previous cases

Dead rats at

Plague rats at

Stables

Disinfection begun at a.m. p.m. 190 ; finished at a.m. p.m 190 .

Rooms disinfected (4) , viz. :

Clothing, &c., (as per attached list) removed for disinfection at a.m. p.m. 190 .

" " " returned to owner at a.m. p.m. 190

Further Data—

Names of Workmen.

Sanitary Inspector
Supervising Disinfection.

1 To be filled in by Secretary.
2 Cottage, villa.
3 Number.
4 No. of rooms, attic, basement.
5 Detached, terrace, &c.
6 Present, past

APPENDIX B.

APPENDIX B.

ADDRESS on the EPIDEMIOLOGY OF PLAGUE.* By J. Ashburton Thompson, M.D., D.P.H., Honorary Fellow of the Incorporated Society of Medical Officers of Health, Honorary Member and Fellow of the Royal Sanitary Institute, Corresponding Member of the Epidemiological Society of London; Permanent Head of the Department of Public Health, Government of New South Wales.

I ACKNOWLEDGE gratefully the privilege conferred by the Executive of the American Medical Association in extending to me its courteous invitation to deliver an address on plague; and I have accepted it with the less hesitation that at Sydney we have had the good fortune to watch successive epidemics under conditions so favourable to complete observation, that probably we may have been enabled to see some things clearly which elsewhere have remained obscure. On behalf of the medical profession in New South Wales who have taken their part in the work, and whom, on this occasion, I poorly represent before you, as well as on behalf of my accomplished colleagues of the medical staff of Government, I thank you, and for myself bespeak your indulgence.

I. INTRODUCTION.

1. *Discordant views on the ætiology of plague and their causes.*

It is now twelve years since it first became possible to study plague by modern methods, and yet no conclusion on its ætiology has been reached which has met with general acceptance. Two causes, as it seems to me, have chiefly contributed to this disappointment. One consists in the appeal which has been persistently made to bacteriology for lights which, in fact, are not in its power to shed; the other in neglect of the epidemiological method, or at least failure to apply it effectively. In consequence, a field has been occupied by the bacteriologist which could not be profitably laboured by him alone. The epidemiologist has not seriously disputed this usurpation of his domain, and for his apparent apathy he has not been without excuses of some weight.

2. *Limitation of previous epidemiological investigation into plague.*

Plague has almost always prevailed in countries inhabited by races foreign to the observer in their language and modes of thought, who were of little instruction, of an education limited to ancient and immutable conventions, and who lived for the most part under conditions which unavoidably obscured the phenomena. It has thus often been impossible to acquire that exact and complete knowledge of all the circumstances under which the infection had been received by each person attacked, which is the foundation of investigations into the ætiology of disease by the epidemiological method.

The conditions adverted to notoriously existed at Hongkong and in India; they made themselves more or less completely felt in New Caledonia, in Madagascar, in Mauritius, in Egypt, and in parts at least of South America; and they obtained effectively in South Africa where, although the ruling population is English, the burden of disease fell on the natives and on immigrants from the East. But plague has visited some places where the conditions were more favourable to investigation, and from them (as well as from those just mentioned by name) much information of clinical, pathological, and administrative value has been forthcoming; but there the principles and uses of the epidemiological method seem to have been greatly overlooked.

3. *Relative absence of such limitation at Sydney.*

At Sydney the conditions happened to be much more favourable to its employment. The invaded population numbered about 500,000. It was not merely wholly white, of English extraction and speech, and fully civilised, but intelligent, instructed, and orderly, accustomed to direction and amenable to it. Management of the outbreaks rested solely with the central Department of Public Health, which had not merely wide statutory powers, but in unforeseen contingencies had the practically unlimited authority which the Executive Government occasionally conferred upon it. It enjoyed a measure of absolute power, therefore; and I need not tell those who have in mind the brilliant sanitary campaigns of Havana, Manila, the Isthmus, and New Orleans, that our knowledge can be used to full advantage of gravely afflicted communities only when some such power is entrusted to the supreme health authority.

4. *The subject of investigation.*

I have not drawn attention to these circumstances unnecessarily. They constitute the condition precedent to success in any epidemiological investigation to which, as is the case with plague, co-operation of the people themselves is requisite. So advantageous were they indeed, that I am tempted to refer to our observations as "normal observations," and to our results as "normal results." The subject of inquiry, it is well to add, was not plague in general, but epidemic plague in the two clinical forms which at present are distinguished as the bubonic and the septicæmic. From them the third clinical form, known as primary plague pneumonia, differs so remarkably in its mode of spread, which is simply by direct communication from the sick, and is so much less commonly encountered that it may be left aside.

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* Read before the Congress of the American Medical Association, Boston, 1906.

5. *Conclusions on the ætiology of plague reached at Sydney.*

With the great mass of data which the epidemiological method placed at command, and which has been fully set forth in a series of published official reports, I have framed the following conclusions by induction :—

(*a*) Plague owes nothing of its epidemic form to communication with the sick ;
(*b*) Plague in the rat is a necessary factor in epidemic plague ;
(*c*) A living intermediary is necessary to communicate the infection from rat to man ;
(*d*) That intermediary must be the flea in one or more of its many species.

II. PHENOMENA OF EPIDEMIC PLAGUE.

1. *The infection is not diffused by communication with the sick.*

(*a*) *Direct communication.*—In 1900, when plague first made its appearance in this quarter of the world, and at Sydney, the disease was generally thought to be maintained and diffused by communication with the sick.

In "The Bombay Plague : Compiled under the Orders of Government by Captain J. K. Condon, Indian Staff Corps. Bombay, 1900," ignorance of the origin and modes of spread of plague was deplored (p. 12). While escape of persons employed in hospitals was taken to show "that the germs produced in the bodies of the sick were but little infectious to healthy persons under ordinary circumstances" (p. 72), it was, on the other hand, stated that "the microbe is capable of thriving and multiplying outside the animal body . . . ," so that "the germs may be conveyed by persons who are themselves insusceptible to plague, and having grown and multiplied on suitable media . . . may infect large numbers of people . . . " (p. 69). And the general trend of Hankin's observations was said to indicate that the chief source of infection would more probably be found in "the recently passed excreta of men and of animals suffering from the disease" than in a saprophytic growth in the soil (p. 111). At the date mentioned exact evidence on the communicability of plague was not possessed.

At the present date official opinion in India is that communication with the sick is a means of maintenance of the disease, and must be borne in mind in framing preventive measures. In a resolution of the Government of India, dated Calcutta, 17th January, 1906, designed to place on record in concise form the results of practical experience acquired in the management of plague during the preceding five years for guidance of Presidency and Local Governments, the following sentences were included :— " . . . the inspection of travellers by railways, road, and steamships is often successful in averting or delaying the spread of plague . . . " (par. 6) ; "The example of prisons proves that quarantine may be relied upon to prevent the spread of plague by human beings . . . " (par. 7). "The removal of the sick to hospital . . . is instrumental, however, in delaying the spread of the disease . . . " (par. 8).

That outbreak consisted in 303 cases, and the requisite particulars were learned in 289 of them. Those 289 persons had lived in 276 dwellings ; 266 of the dwellings had harboured but a single case apiece. After an interval of fifteen months, during which no plague had been seen either in man or in animals, the second outbreak began. It consisted in 139 cases, which were found in 124 dwellings (including one ship long in port) ; 115 of those dwellings harboured but a single case apiece. Subsequent experience has been precisely the same. The patients were very promptly removed to hospital after notification, no doubt, but in the vast majority of cases which came under treatment notification was delayed until the third day of illness, or later still ; additional to them were fifty-one persons who died at home at, or before, the hour of notification. All these persons, then, had ample opportunity of communicating their disease to their house-mates, but, as appears from almost all the dwellings having harboured only one case, they did not do so. Further, many of these persons received the infection at the centre of the city which was the original point of invasion, and retired to their dwellings as soon as they began to feel ill. Those dwellings were situated in large proportion in the suburbs, from 2 to 3 miles up to about 10 miles away from the centre ; and about a dozen persons reached places some hundreds of miles away where they passed through their illness under circumstances which did not permit of isolation from the rest of the family, nor, perhaps, from their neighbours. In all of the very distant places, and in a very large proportion of the suburban places, no plague either in man or in animals was afterwards seen. Non-communication was the rule, then. Secondary cases did occur occasionally ; but I shall show that they resulted from exposure to a common source of infection, not from communication with the sick.

Even in India it has turned out to be possible to examine the question of communicability in a similar way ; and as soon as it was so examined similar evidence was obtained. In his report on plague in Calcutta, for the year ending 30th June, 1904, Dr. T. Frederick Pearse, Officiating Special Health

Officer, stated the figures for three of the districts of the city. In District I, 1,521 cases occurred ; 1,002 huts furnished only 1,173 cases, and 287 pucka buildings only 316 cases (and 32 cases were undistributed). In District II, there were 2,049 cases ; 1,023 huts furnished only 1,222 cases, and 642 other buildings 827 cases. In District III, there were 728 cases ; 539 huts yielded but 582 cases, and 127 pucka buildings only 137 cases (and 9 cases were undistributed). Unfortunately notification was far from complete, though improved ; however, Dr. Pearse thought that this evidence weighed against maintenance by communication with the sick, against indirect communication by fomites, and against persistence of the infection on premises.

(*b*) *Indirect communication.*—Dissemination of the infection by means of articles which had become infected in plague-houses so as to contribute importantly to production of an epidemic, if at all possible, could take place only if those who suffered commonly pawned or sold their household goods during illness. As a matter of fact, no such diffusion of articles took place. Distress, consequent on illness and loss of work, had not time to make itself felt before the houses fell into the hands of the disinfecting staff. But were the infection commonly capable of being spread indirectly by infected articles, no such clear answer as that given to the preceding question could have been made. We have no ground for suspecting that the infection of plague can be spread by clothing, bedding, or other articles of household use.

Can articles which were not infective within houses become so as a consequence of mere removal outside the houses ? Accounts are forthcoming from India of transmission of this infection with clothes, or by persons who were not themselves suffering. The surrounding circumstances in which such cases were observed have not been described in the requisite detail ; however, had sufficient experimental evidence that fleas could communicate plague been already adduced, then it would be easy to understand how articles which appeared to be not infective within houses might become so after issuing from them. For during transport the fleas would be starved, and they would seize the first opportunity of taking blood (Tidswell—Report, Sydney, 1902, p. 73 ; Gauthier et Raybaud, "Revue d'Hygiène," XXV, p. 426, May, 1903). It should be noted with reference to those Indian accounts that our people, having been respectable artisans for the most part, were not infested with vermin as the poorer natives of India generally are.

The evidence, then, collected under the usual conditions of civilised life in 1900, and in 1902, suffices to show that neither direct nor indirect communication with the sick is a factor in causation of epidemics. This fundamentally important judgment has been fortified by all the experience of subsequent years. It carries with it the corollary that *the infection spread in epidemic form by means which were* (*a*) *external to man, and* (*b*) *independent of his agency.*

2. *The infection is associated in some way with locality.*

The disease claimed many victims, although it did not spread from person to person. The infected must have shared something, therefore. We discovered what this was as soon as scrutiny of dwellings in relation to infection was exchanged for scrutiny of work-places. Already, in 1900, seventeen groups of cases had been noted which consisted of from two to four persons in each, the total number concerned having been forty-three persons, who occupied forty-three separate and scattered dwellings. There was no other bond between the components of each of these groups than resort to the same work-place. In subsequent years we met with other groups of which the component persons were connected solely by resort to the same work-place, the same hotel, or (in one case) even to the same theatre. Under our "normal conditions," we were able to establish the important facts concerning each of them fully, and quite certainly.

3. *Incidence of the disease on households is erratic.*

Yet infectiveness of the locality did not insure the infection of persons present in it. On the one hand non-communication of the disease from the sick prepared us to meet with but single cases in dwellings, and that was the rule ; on the other hand connection of the infection with locality seemed to make it almost certain that secondary cases must be met with in buildings which were places of infection for primary cases. Accordingly, secondary cases often occurred in buildings which were infective ; nevertheless much the most commonly only one person suffered out of several who were equally exposed, and who (since man's natural resistance to plague is very slight) were all equally susceptible. I wish here to direct attention more especially to the very commonly observed escape of all but one member of the exposed group. It has from the beginning caused me to suppose that a chain of circumstances which is rarely complete in all its links must be necessary to the infection of man—(Report, 1900, p. 36).

4. *Extension of local infection by contiguity.*

The infection always first made its appearance at some one spot; never at more than one. From that spot it extended continuously, and its progress could be watched. The limits of the area on which it was present could be and were ascertained, time after time ; and although in the nature of the case they could not be sharply defined, it was always possible to say where plague-free areas existed beyond them. This way of spreading I distinguish as "extension by contiguity."

5. *Extension of local infection per saltum.*

While the infection was manifest only at the point of primary invasion, it often made appearance quite suddenly at some distant point, and there created a new focus. The intervening country although covered with houses remained unaffected either permanently, or until some very much later date when it became infected by contiguity, either from the central focus or from the secondary focus itself. It appeared that the infection could be transported safely, be planted afar, and could there take effect. In that there is nothing novel, for the same happens with several communicable diseases. It becomes remarkable and important when it is remembered that, in accordance with our fundamental observation, the infection of plague is not maintained or diffused by communication with the sick. This way of spreading I distinguish as "extension *per saltum.*"

6. *Incidence of the infection on houses is erratic.*

From the beginning it was observed, as well in urban as in suburban districts, that infection of a house betokened no particular danger to the adjoining houses. But it did betoken danger to houses in its neighbourhood. It was remarkable that the apparently imminent danger was realised but rarely, while the apparently remoter danger was almost invariably realised sooner or later.

7. *Sub-epidemics.*

For convenience of description outbreaks which result from extension *per saltum* may be called "sub epidemics." In reality they have their own independent status, and are as much entitled to be named "epidemics" as is the outbreak at the point of primary invasion. The sole difference between the primary and such secondary outbreaks is this: Whereas the infection was carried from great distances oversea to the point of primary invasion, it was carried from that point to the secondary foci over the shorter distances which separated them from it. The numerous secondary outbreaks which we have witnessed were not the less independent that they were isolated by but a mile-wide ring of plague-free houses, nor the more independent that they occurred (as we have seen) 70 miles or 300 miles away from the point of primary invasion; nor were those distant sub-epidemics less independent than was that at the point of primary invasion itself, though the latter may have stood thousands of miles from the source of its infection. A consequence of great value in the epidemiological investigation of plague flows from this. It is that sub-epidemics can be compared with the primary epidemic, and with each other. Even in a single city checks on observed data thus become available; corroboration, also, on points which stand the test of such comparison. It will appear presently, I believe, that the mode of diffusion of plague is always one and the same, and that distance is an incidental accompaniment, without real significance, and of very little practical importance.

8. *Infected areas.*

It is customary to speak of "infected areas," and the phrase is convenient for administrative use. But in epidemiological terminology it is inexact. Our "normal results" have shown that the infection of man is almost always contingent on his presence within buildings of some sort. Infectiveness of areas is entirely conditioned by the infectiveness of some of the buildings which stand upon them.

9. *Non-persistence of the infection in localities.*

The infection is but casually connected with localities; it does not inhere in them.

(*a*) *Districts.*—The after-history of a good many areas on which sub-epidemics have occurred, raced during terms of years from six downwards, has shown that the most ordinary processes of scavenging and cleansing as applied to accumulations of rubbish, dilapidated buildings, backyards, and basements, has sufficed to banish the infection. Any such area might of course become reinfected *per saltum* from any other distant area with which it remained in unguarded communication; but in the many instances I now have in mind this happens not to have occurred, with a single conspicuous exception. This consisted in the central area itself. One small part of our extensive wharf-lines has always been the point of primary invasion; it does not measure much more than a mile in length. I shall be able to show at the proper time, that this is one of those exceptions which prove the rule. Our "normal" observation is secure; simple scavenging of rubbish and filth without any general disinfection or other special method, gets rid of the infection once for all.

(*b*) *Houses.*—221 houses were adjudged in 1900 to have been the places at which many of the 303 cases of that outbreak had received their infection; they were infected houses, and the cases they yielded were "indigenous" to them. In 1902 the disease revisited the area on which those 221 infected houses stood; and then 86 houses were adjudged to have been places at which 113 persons received their infection. But in the second epidemic large areas which had carried places of infection in the first epidemic were entirely spared. No fewer than 215 of the 221 plague-houses of 1900, escaped in 1902; and as regards the six houses which were revisited in the latter year, only four of them could be regarded as having been places of infection in both years, the other two having merely harboured persons who were adjudged to have received the infection elsewhere. Since the infection recurred in the second outbreak on the same area, it was manifestly probable that a few houses would be invaded a second time; and that, I think, is the proper view to take of the very small residuum of four houses out of 221 which were places of infection in both years. This exact statement has been supported by the result of all further "normal" observation. As the infection does not inhere in localities, so neither does it inhere in buildings; but to both it may be reimported.

The suggestion that plague is an infection of locality has authority. The Chinese have always (as far as we know) held the opinion that plague emanated from the soil, and probably they deduced it from having observed that what they took to be the same disease as killed animals which live near to or in the soil afterwards attacked man. They elaborated it into the fantastic theory on which plague was thought by them to attack many kinds of animals in a succession regulated by the height at which they carry their heads above the ground, so that man suffered last. This belief, that the infection of plague resides in the soil, has been entertained and advocated by Creighton, who adopted it in his "History of Epidemics in Britain," and reaffirmed it in 1905, after having paid a visit of investigation to India. He thought the infection rose to the interior of dwellings with the ground-air, and was commonly taken by man with the breath. (Journal of the Society of Arts, LIII, pp. 813 and 824). The belief "that plague is essentially a disease of locality," and that houses are infective in themselves, is general in India (English Plague Commission in India, par. 221).

Our "normal" observations have furnished no support to this view. As it appears to me, the infection can only exist under the following forms—(*a*) as an infection of the animal body, be it vertebrate or invertebrate; (*b*) as a discharge from the animal body on inanimate objects, to which I have allocated the phrase "deposited infection"; and (*c*) as a saprophytic growth. But I have just given some reasons, and before concluding I shall adduce others, for thinking that it does not exist in efficient form (efficient, that is to say, *quâ* epidemic prevalences) outside the animal body.

10. *Outline of the epidemic form.*

The general form of our epidemics, and of all epidemics (except those of primary plague-pneumonia) concerning which the details are sufficiently known is—(*a*) commencement in a very few cases which are separated from each other by considerable intervals of time, (*b*) a more rapid succession of cases, and (*c*) a conclusion resembling the commencement but, as a rule, not so long drawn out. This outline is clearly seen when the number of cases is considerable, but it is lost when the number is small, and the character of the outbreak then seems to be mere irregularity of the order of succession; the intervals between the cases being often many times as long as the incubation period of the disease.

The latter point is conveniently illustrated by our fourth outbreak, which consisted in twelve cases only. I give the intervals after premising that the incubation period of plague is most commonly three days or less, and perhaps may be said never to exceed five days. The date of attack in the first case of 1904 was 9th of March; the successive intervals at which the remainder occurred were 32, 10, 12, 3, 13, 17, 6, 20, 41, 38, and 3 days (but the last two cases occurred in the same house).

11. *Epidemic plague is associated with epizootic plague.*

Our investigation of the twelve cases in which the small outbreak of 1904 consisted was pushed to the last extremity. It will be well worth while to examine the places of infection under their group-aspect at this point, for we are on the brink of an important transition. The number of infective premises was nine; seven of them, of which two furnished two cases each, were grouped by standing at or near the point of primary invasion; the eighth and ninth (which latter also furnished two cases) stood about 6 and about 10 miles away from it in opposite directions, and were infected from it *per saltum*. Now, we have learned already that the infectiveness of districts is conditioned by the infectiveness of particular houses which stand within them; and when the relationship of the seven premises which in the district-sense were grouped was examined more closely, it appeared that in reality they did not stand near each other, but in almost every case were rather widely separated—separated, that is to say, by two or three blocks, by a quarter of a mile of city property, or even by longer distances. Something they shared, for they were all infective; but that something can have had no essential or necessary connection with the area on which they stood. We found the circumstance which was common to all of them in the presence of plague-rats. That, and that alone, distinguished the district in which seven of them stood, and the two distant, separate, neighbourhoods in which the eighth and ninth stood, from the rest of the metropolitan area. I have mentioned these results in connection with 1904 partly because the small number of cases makes that outbreak a convenient example, and partly because in that year we established the distinction mentioned, namely, the presence of plague-rats in every case without exception; but it had also been observed by us in previous years.

* * * * * * * * * * *

If all the "normal results" which I have described separately be now considered together, I think it will be conceded that nothing can co-ordinate them, and reconcile the apparently contradictory features of some of them, except the assumption that *the infection of plague exists in, and is disseminated with, the bodies of some species of lower animal which is free to wander.* Thus the centre of interest passes for the present from man, to the only animal which at once lives in close association with him and is conspicuously subject to plague.

III. PHENOMENA OF EPIZOÖTIC PLAGUE.

1. *Need to watch the rat closely and continuously.*

The association between plague in man and in rat which has now been very frequently observed in many different parts of the world tempts the inference that man takes plague from the rat; and it has been very generally drawn. However, on reflection it will appear that no good ground of inference has thus been disclosed, and that in reality only a coincidence has been noted which collateral circumstances have shown to be worth investigation—the scent, not the quarry. But systematic investigation has rarely been accorded to it. As a rule the observed points consist solely in (*a*) plague in man, and (*b*) concurrent plague in the rats in his neighbourhood. Nothing is known, or at least nothing has been intelligibly recorded, of the rats over the whole of any town, in the parts where plague is not as well as those in which it is. Hence the question of causality has been left open. A suggestion that both may have taken the infection from some common source remains plausible; and it is by no means disposed of by showing (as has been shown with that intention) that persons who live away from the rat-infested neighbourhood only take the disease if they resort to it, or only after diseased rats have been observed in the neighbourhood of their dwellings. In order to elucidate it, it is necessary that the rat should be watched all the year round, while plague is present and when it is absent; and in reporting results it is further necessary that the duration, extent, and means of search, as well as the way in which infection with plague was ascertained, should be carefully described. This has not yet been done in India; and it is precisely in India that many experiences have been recorded from which, it is said, it has been learned that epidemic plague can occur out of association with rat-plague. I am going to show that although plague rats do in India and in some other countries often come out to die in the open, and thus to some extent offer themselves for inspection, systematic detection of rat-plague is in reality a difficult business.

The methods employed at Sydney fell under two heads; rat destruction and rat intelligence. *Rat destruction* was secured by payment of a capitation fee for carcases to the public; the carcases were delivered at furnaces where they were recorded and burnt. The furnaces were in charge of intelligent men of the temporary staff, who were directed to report any general information they might pick up. None of the rats received there were examined in the laboratories, because good information as to the places at which they had been taken could not be got from the persons who usually delivered them. *Rat intelligence* was got through a special staff, which consisted at first of the best men we could find; but by a careful process of weeding out a trustworthy corps was gradually got together, most of whom at the present date have been continuously employed since the beginning of the second outbreak, 1901–2. The provenance of all rats taken by this staff was accurately known. The catch of the previous night was delivered at the laboratories with the address at which each animal had been taken attached to its carcase; the address was entered in the rat register; the carcases with their attached addresses were handed to the staff of laboratory assistants, and were examined by them under supervision of the Director. The results were then entered in the register. As soon as plague was detected in a carcase which came from a house not previously known to carry the infection, the address was communicated to the medical staff, and was spotted on a map; the sanitary staff was instructed to repair to the premises with their scavengers and cleansers; their operations began with the infected premises and the adjoining premises on each side of them, but were extended to the whole block. Every rat taken during these cleansing operations, as well as the particular premises in the block on which it had been found, was also examined and was recorded. The general sanitary state of the block was reported in detail by the Sanitary Inspectors (all of whom were trained and certificated); they drew attention to matters of special importance, and these were further examined by a Staff Medical Officer. This method has been followed continuously since 1st April, 1902, and is effective at this moment. In plague-free times there has been no need for it in some of its details; but examination of rats by means of the intelligence staff has never been intermitted. Their work has not covered the whole of the 256 square miles of the metropolitan area, any more than it has extended to the whole of the 311,000 square miles which the State comprises. Experience has taught us that when the infection reappears it will be first found at the short length of wharf line already mentioned; and to a wharf line of about 4 miles in length which includes that portion, and to the immediately adjacent streets of the city, the unremitting work of the intelligence staff has been confined in times of peace. Every item of information has thus been systematically recorded; and nothing concerning plague among the rats of Sydney which can be learned in such ways, neither as to its presence nor as to its absence, remains hidden from us. But I would not draw an exaggerated picture. We had to learn this business ourselves, and we had to teach the public, without whose intelligent help much of what we know must have remained undiscovered; and therefore, although the above statement is quite correct, it should be noted that we improved both in accuracy and completeness as experience accumulated, and our teaching spread.

The Director of the Laboratories was Dr. Frank Tidswell. I shall often have occasion to refer to his special work, when time permits; it sufficiently testifies his industry, skill, learning, and judgment, I believe, to those who have made acquaintance with it in the series of reports on this subject which has been published.

Invariably I use the word "identified" in relation to plague, to indicate discrimination of the disease by morphological, cultural, and inoculation methods, comparatively applied in all their respective details. Suspected plague, whether in man or in animals, was thus rigidly investigated whenever circumstances rendered certainty desirable (in first cases, for instance; in all other animals than the rat—marsupials, whose susceptibility to this infection was first noted by Tidswell; in "naturally-infected" guinea-pigs, because at our date of observation this event had been but once before recorded, and in a summary fashion; in all cats, dogs, &c.; and in all cases met with or suspected on board ship).

2. *Species of Rats.*

It is convenient to speak of the rat in general, but I wish to be understood to comprehend under that word three species and a variety. These are *M. decumanus*, the grey rat; *M. rattus*, the black rat, with its variety, *M. Alexandrinus rufus*; and *M. musculus*, the grey mouse. We meet with all of them; all suffer from plague in nature in epizoötic form; and we have found all of them associated with plague in man.

M. decumanus is the grey rat; it lives in burrows, infests sewers, basements, and rights-of-way, and feeds on garbage. It can by itself cause plague in man, as we saw in the case of the troopship "Antillean" which carried no other species, and on which two cases of plague occurred in port, but before pratique had been granted (Report, 1902, pars. 50–64). We have also found this species far from any town on the banks of a river 300 miles north of Sydney, where, no doubt, specimens had been originally landed from Sydney cargo boats. At the time of examination they extended to premises inland, where they were found in the village and on farms; there, also, they alone were the cause of 12 cases of plague, of which 7 were fatal, and which occurred in 10 houses. Large numbers of rats were examined; there were but half-a-dozen *M. rattus* among them, all of which were plague free, while all the infected rats, of which there were many, were *M. decumanus* (Report, Sydney, 1905). This species cannot be tamed, and in captivity soon dies, as a rule.

M. rattus is the black, or ship rat; together with its variety, *M. Alexandrinus*, it prefers upper floors, roofs, sometimes the branches of climbing plants, and feeds on grain and fruits. This species is easily tamed, and lives, but will not breed, in captivity. We have found *M. rattus* alone in connection with plague in man; we have also found it in the same connection in conjunction with infected *M. musculus* only, and apart from *M. decumanus*. It, too, can by itself cause plague in man.

The opinion formed from our four years' continuous examination of rats is that at Sydney they breed all the year round, but probably a little less freely in the four colder months. At Brisbane, Queensland, which lies about six degrees further north, it is thought that they breed all the year round without variation.

Mice are less susceptible to experimental plague than are rats; from the following I infer that they may also be less susceptible in nature. During the epizoötic period, 1st March to 3rd December, 1904, 20,394 rats were examined, and ·9 per cent. were infected; by the same men during the same term 23,428 mice were collected on the same area, of which ·26 were infected. However, it must be remembered that these figures express only what happened to be found, and are incomplete. All the rats were not caught; still less were all the carcases discovered.

Rats eat each other in nature; rather more than 8 per cent. of the carcases brought in have been partly devoured, but sometimes so completely that nothing but the head, paws, tail, and skin remained. We have also ascertained that rats eat mice in nature.

3. *Small proportion borne by infected rats identified to total rats examined.*

I take for convenience the $2\frac{3}{4}$ years which ended on 31st December, 1904. During that term 125,872 rats and mice were examined in the laboratories. Out of this total (which included none of those brought in by the public) plague was identified in but ·37 per cent. On the other hand, the meaning I attach to the word "identified" (see above) must be borne in mind. A large number of putrid carcases came to sight, in which, no doubt, plague had been the cause of death, though it could not be bacteriologically identified; yet if these could be reckoned as well the discovered deaths from plague would still compose but a small percentage of the total taken. Very many plague rats die in their holes, where we have found some of them; the majority remain undiscovered.

4. *Sick rats not often seen in the open.*

With us, the occasions on which sick rats have been reported to have come into the open could be counted on the fingers; they do not commonly discover themselves in the way so often seen in many countries. On the other hand they do die in unusual places, and so regularly that we feel justified in regarding the discovery of three or four carcases at a similar stage of decomposition, under floors, or in, or on the tops of cupboards, &c., during known presence of an epizoötic, as probable evidence of death from plague. In ordinary, as is very well known, rats generally die out of sight: nuisance from them is uncommon. The contrary is the case when plague is epizoötic. Even when poison has been laid, discovery of several dead bodies in such situations should arouse suspicion.

5. *Difficulties of rat-catching.*

Rats have to be searched out therefore; and to illustrate the difficulty of finding them I cannot do better than repeat the following statement:—During a term of eight months, the Intelligence Staff paid 17,656 visits to foreshores, wharves, and stores; only 4,095 of those visits resulted in captures, and the number of rodents taken was only 10,579. These premises were entirely open to the men; but had the area examined been residential it is clear the result would have been still less satisfactory, since admission at night would often have been refused to them.

6. *Healthy rats most often caught.*

The means of catching necessarily selected, namely trapping, is obviously more likely to lead to the taking of healthy rats, active in their search for food, than sick rats, as I pointed out in 1902.

7. *Irregular Infestation of Buildings.*

We have found that all the buildings which seem to be likely to harbour rats are not infested with them. House-to-house examination of a group of blocks of squalid, but solidly constructed, buildings, which contained 387 houses, resulted in finding fifty-seven infested with rats, or about 15 per cent only; although all of them from dilapidation, and a majority from the uses to which they were put, appeared equally exposed to infestation. These blocks, then, furnished an explanation of the erratic incidence of plague on houses which has already been mentioned—not in that these fifty-seven were infected, but, in that they alone were infested.

8. *Small number of Plague Rats usually found on Single Premises.*

The number of plague rats found on premises is usually small—that is to say, from three or four, to half a dozen; but occasionally, and for no obvious reason, the number has been large. I can mention 69, 154 dead and 35 living, 72, 39 dead and 3 living, 80, 45, &c., found, for the most part, at produce stores under the floor of shops which had no basement; but these were quite exceptional numbers.

9. *Slow progress of the Disease in Hordes.*

With those few exceptions, also, the progress of the disease among the horde infesting any premises has been usually quite slow. This is an observation of so much importance that in 1903 I published nine tables in illustration of it. Plague rats and plague mice were taken over quite long periods in conjunction with healthy rats and mice; and notwithstanding disturbance the healthy animals continued to be caught long after the last infected animal had been taken. So that although for some unknown reason plague occasionally sweeps off the whole horde, it very much more often follows a slow course in buildings—as it did also on the troop-ship "Antillean," which was infected at Cape Town, but arrived at Sydney twenty-nine days later with some plague rats and many more healthy rats on board her; and when it does so, the horde does not become alarmed, and does not flee the premises.

Examples of slow progress of Plague among Hordes of Rats.

BADLY-KEPT Stabling for 100 horses, which stood on about 1,500 square yards of blown sand, a long distance from the point of invasion.

Date.	Number examined.		Number infected.		Date.	Number examined.		Number infected.	
	Rats.	Mice.	Rats.	Mice.		Rats.	Mice.	Rats.	Mice.
1903.					1903.				
15 June ...	12	......	11	......	15 July ...	......	3	......	......
16 ,, ...	30	2	18	......	16 ,, ...	......	2	......	1
17 ,, ...	17	9	10	......	18 ,, ...	......	2	......	......
18 ,, ...	20	6	11	1	20 ,, ...	......	2	......	1
19 ,, ...	30	3	13	......	21 ,, ...	......	2	......	......
20 ,, ...	18	7	......	......	22 ,, ...	......	1	......	......
22 ,, ...	7	......	1	......	24 ,, ...	......	2	......	......
23 ,, ...	6	8	......	2	30 ,, ...	2	......	......	......
24 ,, ...	4	5	......	......	7 August ...	1	1	......	......
25 ,, ...	1	3	......	1	10 ,, ...	......	2	......	......
26 ,, ...	......	3	......	1	11 ,, ...	1	2	......	......
27 ,, ...	2	1	......	1	12 ,, ...	1	1	......	......
29 ,, ...	1	6	......	......	13 ,, ...	......	2	......	......
30 ,, ...	2	1	......	1	14 ,, ...	......	2	......	......
1 July ...	......	6	......	1	15 ,, ...	1	1	......	......
3 ,, ...	......	2	......	......	17 ,, ...	1	......	......	......
4 ,, ...	......	2	......	......	18 ,, ...	1	......	......	......
6 ,, ...	......	2	......	......	22 ,, ...	......	1	......	......
7 ,, ...	......	1	......	......	24 ,, ...	1	......	......	......
8 ,, ...	......	1	......	......	26 ,, ...	2	1	......	......
9 ,, ...	......	2	......	......	27 ,, ...	2	......	......	......
10 ,, ...	......	1	......	......	28 ,, ...	1	1	......	......
13 ,, ...	......	1	......	......	31 ,, ...	2	......	......	......
14 ,, ...	......	1	......	......					

PRODUCE Stores at the point of Invasion.

A.

Date.	Number examined.		Number infected.	
	Rats.	Mice.	Rats.	Mice.
1903.				
21 May ...	1	2	......	......
21 ,, ...	......	1	......	1
22 ,, ...	1 cat	1	1 cat	1
22 ,, ...	1	......	......	......
23 ,, ...	1	4	......	1
25 ,, ...	......	3	......	2
26 ,, ...	1	4	......	1
26 ,, ...	......	4	......	1
27 ,, ...	......	3	......	2
27 ,, ...	......	8	......	......
28 ,, ...	......	4	......	1
29 ,, ...	......	7	......	2
30 ,, ...	......	16	......	......
1 June ...	......	8	......	......
1 ,, ...	......	4	......	1
22 ,, ...	......	2	......	......

B.

Date.	Number examined.		Number infected.	
	Rats.	Mice.	Rats.	Mice.
1903.				
16 May ...	2	......	......	......
19 ,, ...	2	1	......	......
22 ,, ...	2	......	......	......
23 ,, ...	1	5	......	......
12 June ...	......	3	......	......
6 July ...	1	1	......	1
7 ,, ...	1	2	......	2
8 ,, ...	1	18	......	......
9 ,, ...	......	2	......	......

C.

Date.	Number examined.		Number infected.	
	Rats.	Mice.	Rats.	Mice.
1903.				
18 May ...	8	4	......	......
19 ,, ...	2	1	1	......
18 June ...	......	7	......	......
19 ,, ...	......	4	......	......
20 ,, ...	1	4	......	......
22 ,, ...	2	2	......	......
23 ,, ...	......	3	......	......
24 ,, ...	......	5	......	......
25 ,, ...	......	3	......	......
26 ,, ...	......	2	......	......
27 ,, ...	......	1	......	......
29 ,, ...	1	......	......	......
30 ,, ...	......	1	......	......
1 July ...	2	1	......	......
2 ,, ...	1	......	......	......
4 ,, ...	4	3	......	......
6 ,, ...	......	1	......	1
7 ,, ...	......	1	......	1
9 ,, ...	3	10	1	5
10 ,, ...	......	4	......	......
13 ,, ...	......	1	......	......
17 August ...	......	2	......	......
18 ,, ...	......	1	......	......
19 ,, ...	......	1	......	......
21 ,, ...	......	1	......	......
22 ,, ...	2	1	......	......
24 ,, ...	......	1	......	......
25 ,, ...	......	1	......	......

D.

Date.	Number examined.		Number infected.	
	Rats.	Mice.	Rats.	Mice.
1903.				
15 May ...	10	5	......	......
18 ,, ...	47	47	......	......
19 ,, ...	1	1	......	......
20 ,, ...	9	......	......	......
25 ,, ...	......	1	......	......
26 ,, ...	1	......	......	......
27 ,, ...	1	......	......	......
5 June ...	3	1	......	......
6 ,, ...	3	1	......	......
9 ,, ...	2	......	......	......
10 ,, ...	1	1	1	......
11 ,, ...	1	......	......	......
15 ,, ...	16	7	3	......
16 ,, ...	8	5	7	......
17 ,, ...	12	5	......	......
18 ,, ...	5	3	2	......
25 ,, ...	......	2	......	1
29 ,, ...	1	......	......	......
1 July ...	1	......	......	......
25 ,, ...	......	7	......	......

10. *Limit of the functions of the rat-search.*

These observations explain at once the long continuance of epizoötics, the small percentage of rats in which plague has been identified, the larger but still small percentage of rats reasonably presumed to have been killed by plague, the slow spread of the disease among the rats, and the small number of separate premises at which presence of the disease in rats was established. Two practical conclusions to be drawn rom them are these : First, a properly organised search can be made to reveal the limits of the area over which the epizoötic extends, but our best efforts will never tell us what the severity of the epizoötic was; secondly, discovery of a single plague-rat should be taken as the signal for strenuous exertion by the sanitary authority in that neighbourhood, and even in that quarter of the town. The percentages given above, it will be noticed, indicate merely what we succeeded in finding, not all that happened.

11. *The interval between epizoötics, and the "bridge" which connects them.*

The intervals between our epizoötics were in order, fifteen months, eight and a half months, six and a half months, and forty-five days. Two causes have been assigned to recurrence and to persistence of rat-plague. One is possible saprophytic persistence of the bacillus, external that is to say, to the animal body; of that suggestion I believe I have disposed as far as Sydney is concerned by showing how easily areas are permanently rid of their infection. The other is that the rat is affected with plague in a chronic form, which causes but few deaths until something occurs to revive its virulence. I do not deny existence of a chronic form; but I say that while on the one hand we have failed to obtain any evidence which points to it, on the other hand we have found it an unnecessary hypothesis. Why had we intervals so widely different as one of fifteen months and one of forty-five days? As regards the former the obvious explanation of its length is that the disease had in reality been extinguished.

This, though unusual, is not unique; Cape Town furnishes a remarkable example of it. The first identified case occurred in February, 1901, the last 2nd January, 1902; altogether 766 were recorded. The first identified plague-rat was taken on 4th February, 1901, the last 19th January, 1902. No further plague case has since been recorded and, notwithstanding steady watch, no further plague-rat (but there was an outbreak of rat-plague at Lady Grey Bridge, a suburban railway-station outside Cape Town in November, 1903, of which no explanation has been published). Cape of Good Hope; annual reports of the Medical Officer of Health for the Colony, 1903. Oporto yields another instance.

As regards the latter we may say without presumption that we know it was cut short by reimportation from another part of our own State. At all events while we had probably infected a northern river district (where an epizoötic began about the middle of December, 1904) by means of the numerous steamers which carry on the produce and dairying trades with it, the first plague-rats in 1905 at Sydney were caught at the very wharf at which those steamers lay to discharge. Secondly, as to the other two intervals of eight and a half and of six and a half months; during them we can say (if our continuous and careful search throughout them availed anything) that we were certainly free from plague in rats; none of the 17,160 taken by the Intelligence Staff during the first, and of the 18,456 taken by it during the second, had plague. Thirdly, from the 18th of January, 1905, to this date, plague-rats have been found continuously; in very small number, and on the very short line of wharves already referred to, it is true, but they were all rats which had died of acute plague. These being the observed and, we believe, the completely observed facts, it seems to me that reference to chronic plague becomes superfluous; and as very little indeed has been ascertained regarding it, further reference to it may be deferred.

Such experience, again, is not exceptional. In accordance with what I said above, namely, that the need to watch rats as carefully as man had been generally overlooked, hardly any precise evidence on this point is forthcoming from other parts of the world. However, much the same thing seems to have been recently observed in Calcutta by Dr. Frederick Pearse (ubi cit sup.); and from returns regularly published by Dr. John A. Gregory, Medical Officer of Health for Cape Colony, it appears that plague-rats in quite considerable number have been taken at Port Elizabeth in almost every week from 23rd August, 1902 (at all events), to January, 1906. As far as I have been able to make out, the same may have happened at Hongkong; but as no one knows, nor ever has known, whether the plague-rats recorded there belonged to Hongkong, or were imported for the sake of reward from neighbouring villages or the mainland, much stress cannot be laid on that (see Report of the Acting M.O.H. on Plague during the first seven months of 1903, p. 6, by Dr. Wilfrid W. Pearse).

12. *Where plague-rats are most constantly found.*

Analysis shows that plague-rats have been found most persistently at wharves, then in warehouses and shops, then in stables, and then in more or less dilapidated cottages. One circumstance is common to all these kinds of places; either they are easily accessible to rats (*Cf.* Hankin on plague at Bombay, Annales de l'Institut Pasteur, XII), or are used in ways likely to attract rats. Such uses are the storage and distribution of food-stuffs. But there is one use which is pre-eminently favourable to rat-infestation, and in connection with which we have most commonly found plague-rats; this is the produce trade in hay, straw, chaff in bags, maize, and potatoes. This point is well and importantly illustrated by our wharf experience. I do not know what the total length of the wharf-line at which sea-going vessels lie may be, but it is many miles. Now I have already said that our continuous examination of rats has been confined in time of peace to a wharf-line which measures only about 4 miles, and that we have learned that when plague recurs it will first show itself at a part of that line which is a little more than one mile long. But we can be a little more exact, and assert with confidence that the chances are that the disease will reappear at some point within the half even of that mile; and that is precisely the part at which the produce trade by sea with other States is carried on. So, also, all our sub-epidemics have begun either at retail produce stores in the suburbs, or at stables to which produce has been carried in quantity from those wharves. If I were asked with what goods danger of the spread of plague is greatest, I should have no hesitation in naming produce of all sorts, returned empties with packing still in them, and bundles of empty bags.

13. *Repeated infection of Sydney.*

In view of the evidence bearing on non-inherence of the infection in place, of that touching the interval between epizoötics, and of that just mentioned which bears on association between plague-rats and a particular class of merchandise, I express with confidence the opinion that the successive epidemics at Sydney have been due not to continuous, but to repeated infection, which has always taken place by sea, and which has generally been connected with the importation of produce. Usually, though not always, the infection must have come to us from neighbouring States, and no doubt we have sometimes returned it to them. Plague has been maintained in Australia, I think, chiefly by an unseen, but traceable, interchange of the infection between ports; but occasional contributions from foreign countries have, no doubt, assisted from time to time, since its first introduction to the Continent must have happened in that way.

IV. MODE OF INFECTION.

It is convenient at this point to consider very briefly the mode in which the infection is received by man.

1. *Inoculation.*

After pondering much that has been written on the pathology of plague, it appears to me that the evidence is greatly in favour of the view that its seat of election is the lymphatic system—a view which has been ably supported by Maximilian Herzog (the Plague; Bacteriology, Morbid Anatomy, and Histopathology: Bureau of Government Laboratories, Manila, 1904); and that it is in favour, further, of the view that the commonest mode of receiving the infection is by inoculation through the skin. This, therefore, seems to me to be the mode of infection to which epidemic plague is due. Other modes are known to have been effective occasionally. Such, for instance, is drop-infection.

The suggestion that plague might be taken by the digestive tract seems to have been first made by Wilm in his preliminary report on plague (Hongkong, dated 20th May, 1896); it was advocated by him in his later and better known paper (November, 1896). He based it on the signs observed at 30 out of 150 necropsies. They consisted in hæmorrhages under the mucous epithelium of the stomach or intestines, swelling of the lymphatic follicles and of Peyer's patches, and sometimes ulceration of the latter. He remarked that general injection of the intestinal mucous membrane was usually present, but in some cases the alterations mentioned were so prominent that they seemed to him to indicate a primary infection of the intestinal tract. No better evidence for this mode of infection has been adduced by the few writers who, from time to time, have since espoused it on precisely the same grounds; its slender character, and its compatibility with origin in toxæmia are apparent.

But he also supported his view by the successful results of his animal experiments, which he made by feeding either with cultivations or with the tissues of animals which had died of plague; in some of them the material was introduced into the stomach by means of a glass tube. These results, he said, meant more than those of inoculation experiments, because they approximated closely to natural conditions. But I would point out that a review of feeding experiments in general shows that success is more likely to attend on feeding with tissues than with cultures; and then, secondly, that such experiments by no means approximate to natural conditions, and at best could never be brought to explain epidemic plague. For the only source from which the food of man could receive the infection sufficiently often must be from the muzzles and mouths of rats, when it would be present in very small quantity, or from contact with their excreta, when it must be in exceedingly small quantity (unless the dung itself were swallowed, which, surely, could rarely happen); and these conditions differ from the experimental conditions in the crucial respect of quantity of the virus taken, if in no other. But they do differ in another respect. It is that the virus administered in the cultures and in the tissues was actually growing, and at the highest pitch of its activity; while the virus casually communicated to food must be in a state of declining vitality, for in competition with true saprophytes b. pestis rapidly becomes overgrown. It is true that Milton J. Rosenau's results (the Viability of Bacillus Pestis, Bulletin No. 4 of the United States Public Health and Marine Hospital Service, Washington, 1901), which agree with those of Tidswell at Sydney (Report, 1902, paragraphs 256–8), and of most other observers, show that the protected bacillus can persist outside the animal body during periods of time which vary with the conditions; but the judicious remark made by Passed-Assistant Surgeon H. D. Gettings should be always borne in mind—namely, that the conditions which obtain in daily life are not on all-fours with those under which exact laboratory experiments are conducted. And I would enforce it by reference to a practical consideration. Our "normal" results have yielded many cases in which workmen were plainly infected at their work-places. Now, these workmen carried their dinner with them in parcels in which it remained until dinner-time came round; and, therefore, although their food was eaten in an infected place it may not be assumed that it was ever exposed to infection. That considerable body of people could not have been infected by feeding.

Wilm's excellent paper is so often referred to as though it were of equal value in all respects that it seems not unnecessary to point out here—though with all respect—that while no other trustworthy observer has ever succeeded in isolating the bacillus from human fæces (in which, nevertheless, it must often be present), he stated that his "culture examinations of fæces gave positive results in all of the fifteen cases examined, where well-marked enteric symptoms were present" (first report, p. 3, *e*).

2. *The bacillus in the blood-stream.*

In accordance with that view is Tidswell's experience that the bacillus is rarely to be found in the peripheral blood-stream before the agonal stage of the disease, in which he agrees with the great majority of careful observers, among whom the Bombay Plague Committee (*vide* supra, the Bombay Plague, 1900, p. 102), Calvert working at Manila (1900–1), and Powell working at Bombay (1904), may be specially mentioned. His method was to incubate the blood in the Widal pipette in which it had been collected for twenty-four hours before examining it. It should be noted that the possibility of cultivating the bacillus in blood *in vitro* does not warrant an inference that it can proliferate in the blood *intra vitam.*

3. *Mechanism of inoculation.*

The means by which the bacillus comes to be inoculated into man has generally been assumed to be by contact between deposited infection and the skin; and it will be remembered that such contact was at first supposed by some to be the cause of preponderance of buboes in the groin in people who habitually went barefoot.

Lowson (Report on the Bombay Epidemic, from 22nd February to 16th July, 1897; by James Lowson, M.B., Hongkong Civil Service, Plague Commissioner to Bombay) had already pointed out in 1897 that the same preponderance was observed among soldiers on plague duty who wore boots (p. 13); and in 1900 we found that no less than 73 per cent of the 286 fully-clothed persons who exhibited buboes had them in the groin. This surmise has now been almost given up.

Tidswell, after having repeated the experiment of Albrecht and Gohn of the Austrian Plague Commission in India on inoculation by application of plague-cultures to the shaved skin of guinea pigs, reached conclusions which warrant the following statement:—(*a*) Before infection can take place in that way there must be a breach of the epithelium, though not a bleeding wound; and (*b*) that breach must be recent, for it becomes repaired in about 24 hours so that infection by that channel can no longer be effected. Those are two limitations which attach to man; but now let the other side of the matter be considered. First, in order to contribute effectively to cause epidemic plague in this way the infection must be deposited by the rat on objects with which man is likely to come into contact; and, secondly, on such objects it does not survive more than three, or perhaps, four days as a rule, and that only when it is protected from the competition for life of saprophytes to which, of course, it is exposed under the circumstances now contemplated. There then, already, are four conditions which must be fulfilled before infection through the skin can take place; and what is more they must be concurrently fulfilled within narrow limits of time. But there is yet another consideration of weight. It is that rats, after all, could thus infect only some few small spots, even in a room; so that when the four conditions have been fulfilled within the requisite time, still the chances are greatly against accidental apposition between that small part of the body which has been injured, and those small spots in a room which have been infected. I believe it will not be thought necessary that more should be said in order to show that epidemic plague, though it be caused by inoculation, cannot be caused by accidental contact between the skin and deposited infection.

V. ASSOCIATION OF EPIDEMIC AND EPIZOÖTIC PLAGUE.

1. *There is a relationship in time and place between plague in rat and plague in man.*

The result of continuous examination of our rats has been to show us that rat plague always coincides in place with plague in man, and in time always precedes it; but the presence of plague rats was not always attended by plague in man. If, however, infection of the rat be a necessary condition of epidemic plague, a closer connection between plague rat and man should be traceable. Accordingly, house association between the two was often discovered. But often, on the one hand, it could not be discovered; and, on the other, often when it was discovered it was not attended by cases in man. Further, the commonly accepted observation that actual contact with the plague rat is unnecessary to infection of man was corroborated, and as a matter of observation was learned to have occurred very rarely. Moreover, such contact when it had occurred, was generally not followed by infection; and that, it will be observed, was in accord with a very extensive laboratory experience which shows that the many persons who now habitually dissect plague rats invariably escape infection, provided they do not wound themselves with their scissors and needles. The contradictory character of these several observations stands forth. The unavoidable inference from them is that if epizoötic plague is a condition precedent of epidemic plague, yet the plague-rat cannot be the only factor concerned. By itself the plague-rat is impotent. Nevertheless, I do not doubt that it is a necessary factor. Indeed, I see strong reason for regarding plague as a disease which belongs to, or primarily affects, the rat; for no ascertained fact has ever shown that it can originate with any other animal than the rat, nor that it ever prevails in truly epizoötic form among any other kind, save one. The exception is a species of marmot (Arctomys Bobac, spermophilus), which is indigenous to Mongolia; but that can have no *direct* bearing on our subject (*see* Zabolotny, Annales de l'Institut Pasteur, XIII, p. 838).

2. *An interval elapses between the beginning of epizoötics and attack of man.*

Let us then survey the epidemic phenomena in hope of finding help in one of them towards solution of the puzzling problem which our " normal " results have disclosed. Out of many things which have been asserted of plagae as the result of incomplete observation, occurrence of an interval between attack of the rat and attack of man stands out as a reality. We have seen it constantly; but we have also seen that it need not be long, as is generally asserted, but may be quite short.

The occurrence of a definite interval is well exemplified by the following observations. We have good reason for believing that our rats were dying of plague on the first occasion during the first week of January, 1900, and that they had probably become infected some time before; but the first case was not attacked till 19th January, the second not until 17th February; and the disease did not become widespread till two or three weeks later still. In the second outbreak immediately after the first case had been notified we ascertained that the infection was already present at three or four separate points; namely, at the produce store at which the patient had been employed, at a wharf where produce was habitually handled, and soon afterwards at another produce store, and at a stable a few hundred yards from it, all the latter having stood a little way inland of the wharf—" *mauka* of it," as the convenient phrase runs in the territory of Hawaii—and all having probably been infected *per saltum* from it. Yet there was an interval of thirty-four days between that first case and the second, and of thirty-five days between the second and the third. In 1903 the epizoötic was recognised on 12th May; but the first of the only two cases which followed was not attacked till 17th June. On the fourth occasion the epizoötic began 29th February at a certain produce store; the first person was attacked 9th March at that store, whence he had removed dead rats as late as 3rd March, and where others were afterwards found and plague in them identified; but the second case did not follow until thirty-two days later. I need not continue the series, for I can say that an interval was observed on every occasion, both in districts and in houses.

3. *Evidence that rats must die before man can be attacked.*

Of this interval many mysterious things have been alleged; but I believe it is now hardly necessary to point out that the first step towards explanation of it lies in recognition of the simple requirement that time must elapse before the rats, which are usually first infected at such uninhabited places as wharves, &c., can sufficiently penetrate to the dwellings of man. But another condition contributes to lengthen it, which cannot be so easily explained. An interval is always observed even between the invasion of individual houses and the occurrence of cases in them. Now, the difficulty of *identifying* plague in rats has already been mentioned. It has arisen in this, that however soon after attack cases have been notified dead rats have been found, and usually they have been found in an advanced stage of putridity. Of this I could furnish very many specific instances, did not time press. It is the common rule. Occasionally prompt notification has led to the discovery of fresh carcases; but always some of the rats found have died already. Plague cases do not occur till rats have died of plague in the house, or in its immediate neighbourhood; then, and not till then, may man be attacked. We shall make acquaintance with what I believe to be the reason for this almost directly.

4. *Seasonal incidence of plague.*

With assistance of the first four outbreaks the seasonal incidence of plague at Sydney can be fixed. The first or crude statement is the following: The first epizoötic began with January, and the last plague-rat was identified in August; the second began in November, and the last plague-rat was identified in July; the third began in May and ended in August; the fourth began in March and ended at the beginning of December. But it requires some adjustment as to the beginning of the second and the end of the fourth outbreak. Although infection of the rats began in November, and evidence of it was found on four separate premises during the latter half of that month, no further evidence of it was got, notwithstanding continuous search, until the middle of January; in other words nothing that could be called an epizoötic then existed. The period of wide-spread plague in the rats did not set in until about the beginning of February. And as to the end of the fourth, although it actually fell in December, still the end of that which could be called an epizoötic prevalence clearly fell in September; the plague-rats identified during the three latter months of that year, numbered only five, two, and one respectively. So that the epizoötic period may be fixed as falling between February and August, there or thereabouts.

And the height of the epidemic period coincided nearly with the height of the epizoötic; March, April, and May, were the months in which the disease was most active in both forms—that is to say, in as far as we could estimate the smaller fluctuations of the latter.

I would here point out again, that collection of plague-rats is never complete, nor nearly complete (unless on board empty ships), and that the numbers collected cannot be taken to indicate inferentially the proportional severity of the epizoötic. The rat-curves so frequently presented cannot be relied upon; they indicate the activity of the search perhaps, and may show its success; or they may only testify to the enterprise and cunning of natives who have brought rats in from outlying places for the sake of a reward.

VI. THE FLEA AND EPIDEMIC PLAGUE.

1. *Necessity for a living intermediary between man and rat.*

The results of "normal" observation, which I have now described, have explained nothing. They have served only to establish a series of contradictions. For instance, while it appears on the one hand that the infection is not diffused by fomites, on the other it has been credibly reported from other parts of the world where the conditions of life differed somewhat from ours, that it has been seen to spread by that means, and not exceptionally. Again, while we have observed association between dead plague-rats and cases, we have seen reason in a small minority of instances for thinking that no plague-rats were present on premises which, nevertheless, had proved infective; more than that, it is quite clear that dead plague-rats are harmless to man. Then, when the presence of plague-rats on inhabited premises has been ascertained, examination of the result has revealed similar contradictions. We have seen that persons who resort to such premises are liable to receive the infection; and yet that association has proved entirely harmless very often indeed. Again, although in that association multiple cases have sometimes occurred, by far the most often only one person has been attacked out of many exposed. I need not adduce more examples. The contradictory character of these and of other events ascertained by us is striking; and it appears from them—a very important point—that the familiar crude observation of local coincidence between rat plague and human-plague, which is logically incompetent to establish causality as between rat and man, turns out to be quite incompetent in fact also as soon as it is examined by the epidemiological method. Indeed, when the crude coincidence is taken together with the contradictions, the resultant evidence strongly suggests that both man and rat take plague independently of each other, from some common source. So far, however, one consideration has been omitted which, in my opinion, has not received due recognition. This, broadly stated, is that the infection has been found external to man's body only in the bodies of the lower animals. Notwithstanding appearances, therefore, it must be that man receives the infection from the rat, although, as we know, the dead rat is certainly impotent to infect him. The crucial question, then, is how it comes to be communicated. Now, *the intermediation of some insect which has the power of taking it from the rat and of inoculating it into man, and which can retain the latter power for a considerable, and perhaps for a rather long, time, is the only means consonant with all the established phenomena which can be imagined.*

2. *Why the living intermediary must be the flea.*

By induction we had reached this stage in 1902. As soon as we had satisfied ourselves that an insect intermediary was necessary, we reviewed our notes to learn which insect was concerned, if perchance they might furnish a hint. I need not detain you with a long description of the search. We found 12 cases in the 1902 series—and more might have been found in the series of 1900 had the notes for that year been sufficiently full, since we found more after 1902—in which solitary buboes, situated in the femoral chain (resultant, therefore, from inoculation in the lower extremity) were exhibited by persons who had certainly received the infection at their work places. There they were all clothed. Their lower extremities were thoroughly well protected, at all events from casual contact with deposited infection, by boots and socks or stockings, and by trousers or petticoats, while their hands, arms, and faces, and sometimes their chests too, no doubt, were fully exposed. Yet they were not inoculated in those exposed parts, but in their protected parts. These cases showed that inoculation must have been effected by some agent to which neither the clothes nor the epithelium offered serious obstacles; by some agent which could evade the one, and which could penetrate the other without causing either noticeable pain or a visible wound. It was perceived, of course, that the flea alone answered these requirements; and then that fleas, which commonly breed within houses in the dust in corners, and in the cracks between flooring-boards, notoriously reach the legs first in places where they are numerous.

3.

3. *What is the characteristic of the season of danger?*

We have seen already that the greatest prevalence of epidemic plague has occurred with us during March, April, and May. The season of danger, which equally includes the time when it is most difficult to arrest epizoötic plague, may be fixed, then, as being the autumn ; for with us midsummer falls in December, midwinter in June. That is the season when most people suffer, and when rats most suffer. It is also the season of fleas. From about February onwards is the time when sandy patches, far removed from dwellings, begin to swarm with them ; when domestic dogs are worried by the species which infests them as at no other time of year ; and when one or other of the rooms in many a house which is neither dark nor dirty, but often of the better class, becomes for a time overrun with them. But although the months referred to are the time of special prevalence of fleas and of their more general obtrusiveness, it must not be forgotten that these insects are to be found all the year round, and in numbers in the warm, dark, places where they best breed.

The more important points in the history of the flea-hypothesis are much as follows :—In 1897 Ogata communicated plague to mice by inoculating them with crushed fleas taken from infected rats (Ogata, Cent. f. Bakt., XXI). In 1898 Simond (Annales de l'Institut Pasteur, XII) formally espoused the hypothesis in a summary of his Indian experiences. He supported it by reference to epidemiological, clinical, and experimental observations, which did infinite credit to his acuteness and penetration in many respects ; but the epidemiological portion was (perhaps necessarily in his circumstances) unconvincing ; his clinical observation of the frequent presence of reaction at the assumed point of inoculation in man has not been confirmed, although it was seen in 4 cases out of a very large number observed at Bombay (The Bombay Plague, &c., 1900, p. 104) and in one at Sydney (Report 1900, p. 56) ; and his experimental evidence was seriously defective. Nevertheless, his paper furnished ample ground for hopeful investigation on the lines indicated by him, and this we undertook with the results which have been described in our series of reports, and summarised in this paper. His experimental evidence consisted in successful repetition of Ogata's experiment, and in four experiments on the communication of plague from rat to rat by means of fleas. They resulted in infection with plague of 1 rat and 1 mouse ; the species of the fleas used was not determined by him, but was probably *Ctenocephalus serraticeps*, since he took them from cats. In 1899 Nuttall (Johns Hopkins Hosp. Reports VIII) reported that several kinds of bacilli, among which plague was not included, soon lost their virulence in the flea's stomach, and he failed to communicate plague by means of bugs (*Cimex lectularius*). In 1900 Galli-Valerio (Cent. f. Bakt., XXVII) made some examination of the question which had been raised whether rat fleas would bite man, and concluded that neither *Typhlopsylla musculi* nor *P. fasciatus* (*Ceratophyllus fasciatus*) would do so. He remarked that *Ct. serraticeps* was rarely found on the rat ; this our experiences in the same year (Report 1900, p. 40) did not contradict, and we now know it to be the case with our rats. Tiraboschi (Arch. f. Hyg. XLVI) also carried out a long series of experiments with *C. fasciatus*, *Ctenopsylla musculi*, and some other less common species, and concluded that neither of them would bite man, but on the contrary showed positive distaste for his skin, although starving. In 1901 Kolle (Zeitsch f. Hyg. XXXVI) made many attempts to communicate plague from rat to rat by this means without success. In 1902 Zirolia, after having worked at Rome with a strain of plague derived from Naples, published a preliminary note (Der Pestbacillus in Organismus der Flohe ; Cent. f. Bak., XXXI) in which he said he had observed that B. pestis not merely survived in fleas for seven or eight days, but multiplied and preserved its virulence. In the same year Tidswell successfully performed Ogata's experiment, and he also discovered that *P. pallidus* was the common rat flea in Australia (*P. Cheopis* Roths.). This species has since been ascertained to be the common rat flea in India. He found further that both that species and our *C. fasciatus* would bite man, if only they were starved ; this experiment was carried out as in mosquito feeding, namely, the fleas were placed in test-tubes, the mouths of which were closed by fine gauze through which they bit. In 1903 Gauthier et Raybaud (Revue d'Hygiene, XXV) made the same observation with *C. fasciatus* and (perhaps) with *P. pallidus* at Marseilles ; and they succeeded in communicating plague from rat to rat by fleas in five instances (*C. fasciatus*). Galli-Valerio (Cent. f. Bakt., XXXIII) returned to the subject, reiterated his opinion that rat fleas would not bite man, and adversely criticised Raybaud et Gauthier's work. In February, 1905 (*Indian Medical Gazette*, February, 1905, p. 43), Liston suggested that the bacillus of plague must be transferred from rat to man as a condition of its continued existence ; and Hankin, in 1906 (Journal of Hygiene, VI), described his dissection of the stomach of a flea which had been taken from the carcase of a plague-free rat found dead during progress of an epidemic of plague. From one half of the stomach he got a pure cultivation of *B. pestis*, as shown by involution forms on salt-agar, &c. ; in the other half he observed bacilli with rounded ends which resembled *B. pestis*, in groups of about twelve each ; from which he inferred that they were growing there, and on their way to reach the salivary apparatus. These two latter suggestions do not seem very probable, for *B. pestis* is a schizomycete. In 1905 Simond (*La question du véhicule de la peste* ; Rev. Médicale du Brésil, 1905) expressed his opinion that *Ct. serraticeps* was, for several reasons, probably the species which most generally acted as agent ; our observations have not supported that view, for, as has been noted by us (Reports 1900, 1902), it has been found on our rats but rarely.

4. *Fleas leave their proper hosts for other kinds of animals.*

It is well known that different species of fleas have their proper hosts, and prefer them to other kinds of animals. Human fleas do not *infest* rats, and rat fleas do not *infest* man ; were it otherwise the rule, perhaps, would be to find multiple cases in plague-houses instead, as is the case, of finding only one person infected out of several equally exposed to the danger. Why, then, should it be supposed that rat fleas will leave the rat for man? In 1905 Liston (ubi cit. supra) made the suggestion that they remain with their proper host as long as it is available, and when it dies, or is withdrawn, proceeds to seek food from the next nearest animal; and he supported it with some interesting observations. He mentioned two instances in which dogs and cats seemed to have saved their owners from attack by *Ct. serraticeps* as long as they were present to afford food; but as soon as they had been withdrawn their owners were bitten. This accords with an observation of my own, namely, although pet dogs are tormented with fleas at the proper season, their mistresses, in whose laps they lie, are not (or very rarely are) attacked. But Liston was able to adduce further and more direct evidence. Rats having died of plague in a public garden at Bombay near a cage of guinea pigs, presently the latter began to die of plague; and on searching the survivors he was able to collect from them a good many specimens of *P. pallidus* (P. *Cheopis*, Roths.), which in Bombay and in Australia is the common rat flea, although guinea pigs in India (and in Australia) seldom possess any fleas at all, and when they do so harbour only one or two specimens of *Ct. serraticeps.* He observed also transfer of the common rat flea from rat to man. His attention was drawn to people who had been expelled from their house by the attacks of fleas. It appeared that on the 6th or 7th of a month the rats in the house had begun to die of plague; on the 11th fleas became so troublesome that the people had to sleep out on the veranda; on the 17th one of them fell ill with plague, and after him another. On the 20th Liston collected thirty fleas on the bodies of the remaining persons. As many as fourteen of them were of the species *P. pallidus*; yet among 246 fleas collected by him from the clothes of various persons under ordinary conditions, but a single specimen of *P. pallidus* was found. May this indicate the reason of our observation that man takes plague only after rats have died of it?

5. *Power of any kind of flea to communicate plague not rigorously established as yet.*

Direct experimental proof of a satisfactory character that it is in the power of any species of fleas to communicate plague is at present wanting; and it should be observed that after it shall have been given, still the epidemiologist alone can say whether the disease actually is commonly so spread. I do not doubt that the experimental proof will be forthcoming some day, and it occurs to me that I shall most usefully conclude my remarks by pointing out the reason for that confidence. It lies in this: We did not test the hypothesis of the flea because it had been put forward; we observed epidemic plague, and then found ourselves obliged to turn to it for an explanation of the phenomena (see Report, Sydney, 1902, par. 299). Without it our "normal" results formed a heterogeneous collection of data which were either disconnected, or actually in conflict with each other; with it we found that those data easily fell into a concatenated series. Thus, to borrow from philosophical terminology, we arrived at a "theory of plague." That harmonious and complete reconciliation of all the observed phenomena certainly holds good at Sydney; and although the mode of diffusion of plague is likely enough to exhibit slight variations of detail under the different conditions which obtain in some other countries, in them also it must hold good in all essentials.

Sydney, 14th April, 1906.

[One Plan.]

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1907.

Legislative Assembly.

NEW SOUTH WALES.

REPORT

OF THE

BOARD OF HEALTH

ON

PLAGUE IN NEW SOUTH WALES, 1906.

On a Sixth Outbreak of Plague at Sydney, 1906.

By J. ASHBURTON THOMPSON, M.D., D.P.H., President,

Chief Medical Officer of Government.

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REPORT OF THE BOARD OF HEALTH

ON A

SIXTH OUTBREAK OF PLAGUE AT SYDNEY, 1906.

BY J. ASHBURTON THOMPSON, M.D., D.P.H., PRESIDENT,
Chief Medical Officer of Government.

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21 January, 1907.

ATTACK occurred on 12th July in the last case of plague in 1905, and the last plague-rat in 1905 was identified 5th December. In 1906 the first plague-rat was identified on 23rd January; attack occcurred in the first case in man on 12th March, 1906, in the last on 22nd December, 1906; and the last plague-rat was identified on 29th December, 1906. The total number of cases was 20, of which 8 were fatal. They occurred in connection with 12 places of employment, and with 18 residences. Of the fatal cases 3 were notified after death; one of these was a case of primary plague-pneumonia, and the same character was ascribed to one other connected with it, of which a history was alone available.

2. The period to be reviewed extended from 6th December, 1905, to 31st December, 1906, and it may be divided as follows:—The precedent plague-free period lasted from 6th December, 1905, to 22nd January, 1906; the epizoötic period from 23rd January to 29th December; and it cannot be said that there was any subsequent plague-free period, for the first plague-rat of 1907 was identified on 10th January.

3. During the precedent plague-free period, 6th December, 1905, to 22nd January, 1906, the Intelligence Staff delivered 2,077 rats, 1,148 mice, total 3,225, all of which were examined in the laboratories, and found to be plague-free.

4. During the epizoötic period, 23rd January to 29th December, 1906, the Intelligence Staff collected 16,849 rats, 10,882 mice, total 27,731, all of which were examined, and among which plague was identified in 135 rats and in 39 mice, total 174. Six other animals were referred for examination, namely, 1 dog, 4 cats, and 1 monkey, all of which were found to be free from plague-infection.

5. The number of rodents destroyed during the whole year, that is between the 1st January and 31st December, 1906, was 54,151 rats, 29,085 mice; total, 83,236. A reward for the carcases of rats and mice was again offered to the public, and was paid from 29th March to 31st December. The numbers paid for were: rats, 36,182; mice, 17,607; total, 53,789, none of which were examined. The numbers collected by the Intelligence Staff during the whole year were 17,965 rats, 11,478 mice, total, 29,447, all of which were examined.

6. The species of rats brought in by the Intelligence Staff were *M. rattus* (with *M. Alexandrinus rufus*), *M. decumanus*, and *M. musculus*, among which the carcases were distributed as follows:—*M. rattus*, 8,694; *M. decumanus*, 9,275; and *M. musculus*, 11,478. The percentages of each species to the total was—*M. rattus*, 29·52; *M. decumanus*, 31·49; *M. musculus*, 38·97.

7. During the epizoötic period alone, the numbers of each species in which plague was identified were—*M. rattus*, 89; *M. decumanus*, 46; and *M. musculus*, 39; and the percentage of the infected rodents to the total of each species examined was among *M. rattus*, ·34 per cent.; among *M. decumanus*, ·49 per cent.; and among *M. musculus*, 1·02 per cent.

The

8. The following abstracts, which have been arranged in the order of dates of notification, exhibit the salient features and circumstances of each case:—

CASE A.

M.M., f., æt. 27, single, dressmaker. No former attack; not inoculated; no communication with any former case. Residence, Parramatta Road, Ryde; employment, American Skirt Co., 346, Kent-street, City; last at work, 12th March. Attack, 12th March, sudden, 8·30 a.m. at employment; first symptoms, vomiting, rigors, headache, backache, pain in right groin. Notified by Dr. A. M. Johnson, 12th, 3·30 p.m.; visited (R.J.M.) 4 p.m.; admitted Coast Hospital, 9 p.m.; discharged 3rd May; duration 53 days. Bubo, right inguinal, solitary; material drawn from bubo 13th March, cultures and inoculation-test, positive.

Rats.—Residence, no signs of infestation. Employment, on the day of attack removed a dead rat from beneath her seat, and stated that rats had been dying on the same floor for a week past, and that the place was infested with fleas. Between 12th and 16th March three or four carcases were discovered in one of which plague-infection was identified; a cat was also found dead, not examined.

Connected case.—None (but there was communication between the joists with No. 348, *see* below).

CASE B.

A.J., f., æt. 19, single, tea-packer. Not inoculated; no former attack, was associated with cases at her employment. Residence, 59, Brown-street, St. Peter's; employment, Oriental Tea Co., 348, Kent-street, City; last at work, 10th March. Notified by Dr. G. H. Bohrsman, 15th March, mid-day; visited (R.J.M.) 12·45 p.m.; admitted to Coast Hospital, 5 p.m.; discharged, 14th April; duration of illness, 35 days. Attack, 10th March, sudden, 3 p.m.; first symptoms, extreme general malaise and feeling of fatigue; pain first felt in left groin, 13th March. Bubo, left femoral, solitary; films and cultures made with material abstracted from the bubo on the 15th, 17th, and 24th March, negative. Lesions on drainage area: two indistinct flea-bites on inner aspect of knee.

Rats.—At residence, no traces; at employment (see general account of this group of cases in the text). The floor on which the patient worked was so overrun by fleas that the continual irritation was said to have interfered with work.

Connected cases.—Was associated at work with cases C and E at or after their attack.

CASE C.

B.W., f., æt. 20, single, tea-packer. Not inoculated; no former attack; in contact at work with cases at her place of employment. Residence, 32, Balfour-street, George-street West; employment, Oriental Tea Co., 348, Kent-street; last employed, 12th March. Notified by the Assistant Medical Officer of Government (Dr. R. J. Millard, M.B. Syd., D.P.H.), in the course of investigating Case B, 15th March, 4·30 p.m.; admitted to Coast Hospital, 16th March; discharged, 14th April; duration of illness, 36 days. Attack, 9th March, evening, headache; 10th, continued malaise, but worked; 11th, Sunday; 12th went to work, but in the course of the morning had a rigor, went to bed, at night first felt pain in right groin; 13th and 14th, remained at home; 15th, sought advice at the out-patient department of a hospital. Bubo, right femoral, solitary; films, cultures, and inoculation-test, positive. Lesions of drainage area, several flea-bites.

Rats.—At residence; no signs of present infestation, one old rat-hole in kitchen. At employment, *see* general account of this group of cases in the text.

Connected cases.—Was associated at work with Cases E and F at or after their attack.

CASE D.

C.L., m., æt. 21, single, tea-packer. Not inoculated; no previous attack; in contact with cases at her place of employment. Residence, 84, Rose-street, Darlington; employment, Oriental Tea Co., 348, Kent-street, City; last employed, 15th March. Notified by Dr. R. Davies, 16th March, 9 30 a.m.; visited (R.J.M.) 11 a.m.; admitted to Coast Hospital, 4·30 p.m.; discharged, 9th April; duration of illness, 29 days. Attack, 12th March, morning, feverish with headache; worked 13th, and on 14th until 11 a.m.; returned to work 15th, and at 9 a.m. first noticed pain in left groin, but continued at work; consulted Dr. Davies during the evening. Bubo, left femoral, solitary; films and cultures (16th March) negative, culture and inoculation-test (17th March), positive. Lesions of drainage area; a few fading flea-bites, inner surface of left knee.

Rats.—At residence, no signs; at employment, *see* general account of this group of cases in the text.

Connected cases.—Was associated at work with cases B, C, E, F, at or after their attack.

CASE E.

E.E., f., æt. 23, single, tea-packer. Not inoculated; no previous attack; in contact with a case at her place of employment. Residence, 31, Nithsdale-street, City; employment, Oriental Tea Co., 348, Kent-street; last employed, 9th March. Notified by the Assistant Medical Officer of Government (Dr. R. J. Millard) in the course of investigating this group of cases, 16th March, 2 p.m.; admitted to Coast Hospital, 7·30 p.m.; discharged, 18th April; duration of illness, 41 days. Attack, 9th March, morning, while at work; strained herself in getting up from her seat, and immediately afterwards felt a sharp pain in right groin which obliged her to cease work; little constitutional disturbance, no headache, no vomiting; when visited, 16th, was dressed, and writing a letter. Bubo, right femoral, a large mass which included several glands, with much periadenitic effusion which filled Scarpa's triangle, only slightly tender; films, cultures, and inoculation-test, positive. Lesions of drainage area, numerous fading flea-bites.

Rats.—At residence, no signs; at employment, *see* general account of this group of cases in the text.

Connected cases.—Was associated at work with Case C after attack.

Case F

A.W.B., m., æt. 40, married, book-keeper. No former attack; inoculated Sydney, 1900; at work on same premises with other cases after commencement of their illnesses. Residence, 231, Ernest-street, North Sydney; employment, Oriental Tea Co., 348, Kent-street, City; last employed, 10th March. Notified by the Assistant Medical Officer of the Government (Dr. R. J. Millard) in the course of investigating this group of cases, 16th March, 4·15 p.m.; not removed to Hospital. Attack, 10th March; felt tired throughout the day, and at night noticed a painful lump in the right groin, without any headache, vomiting, or shivering; stayed in bed, 11th, 12th, and 13th, got up 14th; was never very ill. Bubo, right inguinal, two glands, with periadenitic effusion, not tender; films, negative. Lesions of drainage area, none.

Rats.—At residence, no signs; at employment, *see* general account of this group of cases in the text.

Connected cases.—Was at work in the same house as Cases B, C, D, and E, at or after their attack.

Case G.

R.C., m., æt. 36, married, member of City plague-staff. No former attack; not inoculated; no communication with any previous case. Residence, 54, Thompson-street, City; employment, 346 and 348, Kent-street, between 12th and 16th March. Notified by Medical Officer of Health, Metropolitan district (Dr. W. G. Armstrong, M.B., D.P.H.), 17th March. 11 a.m.; admitted to Coast Hospital, 3·30 p.m.; discharged, 3rd May; duration, 49 days. Attack, 16th March, 5 p.m., pain in left groin, half-an-hour later a rigor, later and during the night headache and vomiting. Bubo, left femoral; films and cultures, positive; lesions of drainage area, several flea-bites on the left leg.

Rats.—At residence, no signs; at employment, *see* general description of this group of cases in the text.

Connected cases.—None.

Case H.

T.G.D., m., æt. 49, married, bricklayer. No former attack; not inoculated; no connection with any previous case. Residence, 8, Botany-road, Alexandria; employment (for three weeks preceding attack), house-building at Petersham, an uninfected suburb; last employed, 7th May. Notified from South Sydney Morgue by Dr. Palmer, 11th May; post-mortem attended by Dr. F. Tidswell. Right femoral gland enlarged and hemorrhagic, surrounded by sanious periadenitic effusion which extended into the pelvis and involved the iliac and lumbar glands. The lymphatic glands of the left groin, the axillæ, and the mesentery shared the general congestion, but were not hemorrhagic. Lesions of drainage area, none found. Films, culture, and inoculation test made with material from the bubo, all positive; films and cultures from right lumbar glands, spleen, heart's blood, and culture made with the urine, all positive.

Rats.—Residence; the cottage was in a small block of insanitary property, the whole of which was or recently had been very freely infested; at the cottage three, and next door two, carcases were found, but too far advanced in putrefaction for bacteriological examination. No suspicion attached to the place of employment, and nothing was found there. The next house to T.G.D.'s was occupied by a fried-fish seller, who also supplied his customers with "chips," and who got his potatoes from Darling Harbour produce wharves.

Connected cases.—None.

Case I.

H.A.T., m., æt. 54, married, a rat-catcher (that is, had recently devoted himself to rat-catching for the sake of the capitation-money); last employed, 4th June. No former attack; not inoculated; no connection with any previous case. Residence, Paul's-lane, Waterloo; employment, irregular; some weeks before had been employed at Yabsley's box factory, 58, Harbour-street, in the Darling Harbour Wharf area, and more recently had trapped rats there as well as elsewhere in that neighbourhood (*see* Cases L and M below); nothing further was discovered concerning his movements. Notified by Dr. P. G. Cooley, 7th June, 4 p.m.; visited (R.J.M.) 4·30 p.m.; admitted to Coast Hospital, 8th June; died, 17th June; duration, 13 days. Attack, 5th June, sudden after waking in the morning, severe headache, rigors, vomiting; 6th, on awaking, found swelling in right groin. Bubo, right femoral, four glands involved; films, culture, and inoculation test positive. Lesions of drainage area: several punctate lesions on right leg, probably old flea-bites.

Rats.—At residence, no signs of present or past infestation.

Connected cases.—None.

Case K.

V.P., m., æt. 39, single, labourer. No former attack; not inoculated; no connection with any previous case. Residence, 12, Winslow-street, North Sydney; employment, Lever Bros.' Soap-works, Balmain; last employed, 20th June. Notified by Dr. Devlin, 22nd June, 9 p.m.; visited (R.J.M.) 23rd, 9 a.m.; admitted to Coast Hospital, 23rd; died, 27th June; duration, 7 days. Attack, 20th June, sudden, 4·30 p.m., violent shivering, followed by severe headache; first complained of pain and swelling in left femoral chain afternoon of 22nd (but was already delirious). Bubo, femoral, solitary; films, culture, and inoculation test positive. Lesions of drainage area, some healed abrasions on the leg.

Rats.—At residence, no signs; at employment, prolonged search failed to reveal anything suspicious, except general signs of a moderate infestation; on and after the 16th patient had been employed with two others in removing a small mess-room, and there was evidence of stench experienced in course of the operations. The works stood in a neighbourhood where plague-rats have never been taken.

Connected cases.—None.

Case L.

H.B., m., æt. 38, married, box-maker. Not inoculated; no former attack; no communication with any previous case. Residence, 38, Cowper-street, Glebe; employment, Yabsley's box-factory, 58, Harbour-street, Darling Harbour; last employed, 23rd June. Notified by Dr. A. A. Palmer, 25th June, 1 p.m.;

visited (R.J.M.) 2 p.m. ; admitted to Coast Hospital, 6·45 p.m. ; discharged, 28th July ; duration, 36 days. Attack, 23rd June, sudden, 8 p.m., shivering, headache, and a painful lump in left groin. Bubo, left inguinal, solitary ; films and cultures positive. Lesions of drainage area ; several flea-bites.

Rats :—At residence, no signs ; at employment, a responsible workman said he had picked up two dead rats and had killed two sick rats about 12th June, and in the course of cleansing 10 carcases were found, but all in an advanced stage of decomposition, and plague was not identified in any of them. A good many rats were trapped at the same time in adjoining and neighbouring premises, in none of which was plague identified. It was here that H.A.T. (Case I, see above) had trapped rats, but the available information referred to some date about the middle of April, or 6 or 8 weeks before his attack.

Connected Cases :—See Case M.

Case M.

J.B., f., æt. 38, housewife. Not inoculated ; no former attack ; not connected with any previous case. Residence and employment, 38 Cowper-street, Glebe. Notified by Dr. A. A. Palmer, 25th June ; visited (R.J.M.) 2 p.m. ; admitted to Coast Hospital, 6·45 p.m. ; discharged, 28th July ; duration, 36 days. Attack, 23rd June, sudden, at 8 p.m. (at the same moment as her husband, H.B., Case L), shivering, headache, general pains ; first noticed a small, painful lump in left femoral region, 25th. Bubo, right femoral ; material taken 26th and 28th, films and cultures negative. Lesions of drainage area, a few flea-bites. By the 28th the bubo had much diminished, and on 8th August had resolved.

Rats :—At residence, which patient had not left for many days before attack, no signs. Clinically this case was one of plague of moderate severity, nor was failure to demonstrate the bacillus in the bubo decisively against that diagnosis ; yet it would seem that the only possible source of infection must have been a flea imported to her house by her husband from the factory, which she herself had not visited. Her attack at precisely the same time as her husband is noteworthy and singular, but was ascertained to have occurred ; perhaps it may be taken, as far as it goes, in corroboration of the suggested mode of infection.

Connected Cases.—See Case L.

Cases N, O, and P.

These were cases of primary plague-pneumonia ; they are separately described in the text.

Case Q.

A.B., m., æt. 16, single, shipping clerk. ; no former attack ; not inoculated ; no communication with any previous case ; residence, Smith-street, Summer Hill ; employment, Slade & Co, 408 Kent-street. Darling Harbour area ; last employed, 3rd July. Notified by Dr. Pockley, 7th July ; visited (F.T.) same date ; admitted to Coast Hospital, 5 p.m. ; discharged, 15th August ; duration, 44 days. Attack, 3rd July, sudden, 2 p.m. ; first sign, pain in groin and discovery of a lump at the same time ; rigor during the evening. Bubo, left femoral ; films negative ; culture and inoculation, positive. Lesions of drainage-area, none made out.

Rats.—At residence, no signs ; at employment, no history, no evidence on search. During ten days preceding attack, had visited many wharves on business.

Connected Cases.—None.

Case R.

F.J.B., m., æt. 15, single, messenger ; not inoculated ; no former attack ; no connection with any preceding case ; residence, 116 Simmons-street, Enmore ; employment, out of place, looking for work. Notified by Dr. G. H. Bohrsman, 11th July, 1·10 p.m. ; visited (R.J.M.), 3·10 p.m. ; admitted to Coast Hospital, 8 p.m.; died 13th July ; duration, 48 hours. Attack, 10th July, sudden, at midday ; general pains and severe headache ; vomiting ; 11th, bubo first observed. Bubo, left, one inguinal and one femoral gland enlarged, small, very tender ; films made 11th July, negative ; p. m. spleen, films negative, culture positive (scanty growth) ; liver, films and culture positive (scanty growth) ; mesenteric glands, film and culture negative ; left femoral gland, films, culture, and inoculation-test, positive ; lesions of drainage-area, many flea-bites on inner side of thigh.

Rats.—Residence, in a poor area, in a very insanitary state ; there were signs of present infestion, but no carcases were found. Extensive cleansing of the block and neighbourhood resulted in identification of one plague rat at No. 118 (next door).

Connected Cases.—None.

Case S.

M.J.S., m., æt. 35, married, wharf-labourer ; residence, Herbert-street, Mortlake ; employment North Coast Co.'s wharf ; last employed, 14th July ; not inoculated ; no former attack ; no communication with any previous case. Notified by Dr. Heatherington, 22nd July, 2 p.m. ; visited (T.W.S.) 5 p.m. ; admitted to Coast Hospital, 23rd July ; discharged 15th August ; duration, 33 days. Attack gradual ; 14th July, tired and feverish after work ; 15th, better ; 16th, left work at noon, and then had general pains, rigors, and vomiting ; on 19th a pustule was first noticed over the right sterno-clavicular joint, which, on the 22nd, had a malignant aspect, and on the same date there was painful swelling of the epitrochlear gland, left arm ; films from pustule, positive ; films and culture from epitrochlear gland, positive ; lesions of drainage area, small healed abrasion on forearm.

Rats.—At residence, no signs of infestation ; at employment, this was an infested wharf at which plague rats were gathered from time to time between the middle of February and the end of August to the total number of 29 (*M. decumanus* and *rattus*).

Connected Cases.—None.

CASE T.

R.G.F., m., æt. 35 years, married, storeman; not inoculated; no former attack; no connection with any previous case; residence, 485 Glenmore-road, Paddington; employment, Osborne and Jerdan, 393 George-street, city; last employed, 30th September. Notified by Dr. J. Morton, 6th October, 7·30 p.m.; visited (T.W.S.) 10 p.m.; admitted to Coast Hospital, 7th October, 11 a.m.; died, 7th October, 9 p.m.; duration, 6½ days. Attack, sudden, midday, 1st October; malaise, general pains, drowsiness; bubo first noticed, 5th; bubo, left epitrochlear gland, with subsequent enlargement of two axillary glands; films, cultures, and inoculation test, positive; lesion of drainage-area, a few slight abrasions.

Rats.—At residence, no signs of infestation; at employment, the basement, where patient worked, had a tar-paved floor which had been perforated by rats, of infestation with which there was abundant evidence; in course of cleansing, six carcases were found advanced in putrefaction, in which plague was consequently not demonstrable. Additionally, the patient had visited the North Coast Company's wharf to book parcels, on 26th September, at all events; this wharf was an infected place (see under Case S). The whole block was searched, and it appeared that rats were very scarce in it; but few were caught, and no plague rat was found.

Connected Cases.—None.

CASE U.

J.J.J., m., æt. 38, married, storeman; not inoculated; no former attack; no communication with any previous case; residence, 31 Richards-avenue, City; employment, Mauri Bros. & Thompson, 46-8 York-street, City; last employed, 22nd December. Notified by Dr. Gledden, 26th December, 11.30 a.m.; visited (T.W.S.) 2.15 p.m.; admitted to Coast Hospital, 27th December; discharged, 21st January, 1907; duration, 31 days. Attack, 22nd December, sudden, 8.30 a.m.; headache and a lump in right groin discovered same time; bubo, right femoral; films, negative; cultures and inoculation-test, positive; lesions of drainage-area, none.

Rats.—At residence, no signs; at employment, no signs of infestation, no carcases, one live rat and two mice caught, all free from infection; rats very scarce in the whole block. Source of infection not discovered.

Connected Cases.—None.

There were three groups of associated cases, of which one consisted of Cases B, C, D, E, F, and G, together with which it will be well to consider Case A; another of Cases L and M, to which should probably be added Case I; and the third of cases N, O, and P. The circumstances under which these grouped cases occurred were the following:—

Case A, and Cases B, C, D, E, F, and G.

9. These cases occurred at 346 and at 348 Kent-street, city. The two buildings adjoined each other and were fine warehouses of identical design and construction; they had five floors, no basement, and at back a small paved yard for waggons, on which other buildings on the Kent-street frontage of the block opened, as well as some on the Clarence-street frontage (see diagram). No. 346 was occupied by a dressmaking company which employed a staff of thirty-five persons; No. 348 by tea merchants. The latter was used for the storage, repacking, and distribution of tea; seventy persons were employed there.

10. On 8th March it was reported to the local authority for the city of Sydney that rats had been dying on the third floor at No. 346 for about three days past, and rat-catchers were told off to investigate; they caught only a few rats which, on being examined in the laboratories of this Department, were not found to be infected. The medical officer of health for the metropolitan district (Dr. W. G. Armstrong, M.B., D.P.H.) thereupon directed search between ceilings and floors on 10th March, but no carcases were discovered until the 12th, when one in which plague was identified was found. On this date also M. M. (Case A) on reaching her room to begin work found a dead rat under her chair and removed it; plague was afterwards identified in it. Here no other cases occurred. During cleansing a dead cat was found one morning, but the carcase was not submitted.

11. The whole block in which these two warehouses stood had been under notice of the city rat staff since 28th February; and between 2nd and 8th March nine carcases had been referred to the laboratories, which had been taken at No. 348; all of them were ascertained to be plague-free. On 15th March the case of A. J., a girl employed as a tea-packer at No. 348 was notified; she had been attacked, 10th March. On inquiry at the warehouse it was found that others were absent from work, and ultimately that four of them had plague; their dates of attack were the 9th, 10th, and 12th. All the cases were of little severity, and all the patients recovered. Four of the five patients were employed on the third floor of the building and in one room; the fifth was the accountant, whose office was on the ground-floor. It was stated that dead rats had been found on the third floor on

several days before 15th March, and all hands agreed that this floor was so overrun with fleas that the irritation consequent on their attacks had impeded the transaction of business. It should be mentioned that the large building was not merely excellently constructed and in good repair but was also very well kept; no other fault could be found with it than the presence of ceilings, between which and the flooring-boards above them there were large accumulations of tea dust and some, but not much, rat rubbish. Search of all floors resulted in discovery of four carcases only and a few deserted nests; the former were too far advanced in putrefaction for bacteriological examination, and plague was not identified in any rat taken in this house.

12. In addition to these six cases a seventh (Case G) occurred in a member of the cleansing-gang, which had been put in to both warehouses on 12th March. The date of his attack was 16th March, and he recovered after an illness of moderate severity.

13. Reference to the diagram will show the situation of these premises in relation to others at which plague-rats had been previously identified, among which that of more immediate importance was 205 Clarence-street, where a plague rat had been found on 5th March, this having been one of the buildings on the eastern frontage of the block which had access to the cart yard at the back of 346–8 Kent-street on its western frontage. The rats taken on these three premises were all *M. rattus*; no *M. decumanus* was found. An attempt to secure fleas for classification failed, because all floors had been sprayed with an emulsion of tar acids (in the form known as "miscible carbolic") before searching and cleansing had been begun. In this connection it may be noted that such preliminary spraying appears to be the best protection to cleansing-gangs, and is always done immediately on entering premises believed to be infected, although in this instance it did not serve to protect R. C. (Case G.)

Cases L and M, and Case I.

14. H.B. was a boxmaker who worked at Yabsley's box factory, 58 Harbour-street, Darling Harbour. He lived in a small cottage in Cowper-street, Glebe, some three-quarters of a mile away, and his wife was the only other occupant. These two were shopping on the evening of Saturday, 23rd June, at 8 p.m., when both suddenly fell ill. Subsequently the infection was bacteriologically identified in material drawn from H.B's. bubo, but not in that from his wife's; her case, however, was very well marked clinically. Both patients recovered. At the box factory, information gathered from the employees, and the discovery of carcases, afforded sufficient evidence of epizoötic plague, although the stage of putrefaction in which the latter were found prevented demonstration of the cause of death. Thus H.B's. case was accounted for. But his wife had not visited the factory, and it was ascertained she had not been away from the street in which she lived for at least a week preceding the date of her attack; she had not been in communication with any preceding case or suspected case; and the whole neighbourhood of her dwelling had been and continued to be quite free from suspicion of infection, notwithstanding close search. The infection must have been conveyed to her by her husband; but it must also have been mechanically conveyed by him, since her illness began at the same moment as his. It may be assumed that his workplace carried the infection, that is to say, in the rats which infested it; but he had not taken home from it anything in which a rat might have lain concealed, and it has been amply shown in this series of reports (for the years 1900-2-3-4-5-6) that man does not become infected from deposited infection, such as might have been so discharged from rats at the factory that H.B. might conceivably have picked it up and carried it home in his clothes. If the ætiology of plague were still where we left it in 1903 (*see* Report, Sydney, 1900, p. 41. conclusion 1, and Report, Sydney, 1902, pars. 262-70) the supposition that the infecting agent must have been a flea carried home by H.B. would still be inevitable, and the curious simultaneity of the two attacks might perhaps be adduced in support of it. Any difficulty which might otherwise have been felt in accepting it, however, has been removed by the ample experimental demonstration that fleas can commonly act as the conveyors of the infection from infected rats to other animals, which has been afforded during the past year by the Plague Research Committee conjointly appointed by the India Office, the Royal Society, and the

Lister Institute. This result of the Committee's researches into agency of the flea, which were conducted under direction of Dr. Charles J. Martin, F.R.S., of the Lister Institute, formed the subject of an interim report which was published as a special number of the "Journal of Hygiene," in September, 1906.

15. As regards Case I, the detail notes above may be referred to. There was evidence of the patient's association with Yabsley's box factory several weeks before the date of his attack. His subsequent movements could not be ascertained, but it seemed quite likely that he had gone there to trap rats from time to time. The last date at which he could have been there—but nothing which showed that he had recently been there came to light—was 5th of June.

Cases N., O., and P.—Primary plague-pneumonia.

16. These three cases came to notice in connection with the death of the second patient; they are described below in the order in which they occurred. This form of plague had not previously been encountered in New South Wales.

17. *Case N.* (not examined either before or after death).—H. G., m. aet. 45, donkeyman on the coasting S.S. "Bega," where he had been regularly employed for the past ten years; residence, 8 Mort-street, Balmain. Married; the other occupants of the house were his wife (C. G., case O) and nine children, aged from 19 years to 6 months. The family was in comfortable circumstances, the house having been a cottage of one storey containing six or seven rooms, well-kept and furnished. G. was in the habit of returning home three times in each fortnight. On 15th June he had sailed from Sydney in the "Bega," being then in good health; he fell ill on the 17th at sea, and left work; he stayed off on the 18th; on the 19th he reached Sydney again early in the morning, and went home. Dr. F. visited him in the course of the day. He appeared to be suffering from catarrh, was visited again on the 20th, and was then thought to have recovered; Dr. F. left him without intention of calling again. But on 22nd June G. summoned Dr. D. late at night, when the presence of pneumonia was recognised; his T. was 100·5°, his pulse was good, and his condition caused no alarm. At 11 a.m. on the 23rd Dr. D. found him pulseless, respirations about 60, and cyanosed; he died very soon afterwards. It was ascertained that at some date, which could not be precisely fixed, but which was less than a week before his attack, G. had observed a dead rat on board the "Bega," which he had picked up with his hands and thrown overboard; for this imprudence he was scolded by the chief engineer, and when another carcase was found in the engine-room, at or about the same date, G. picked it up with tongs and cast it into the furnace. The first intimation of these cases having been received only on 29th June, after the "Bega" had on that day sailed from Sydney again, opportunity of examining the vessel did not occur till 3rd July. After she had been emptied, fumigation with burning sulphur was begun at 8 p.m. on the latter date. After hatches had been lifted on the 4th, thorough search of every part of the ship revealed the carcase of one rat only, which was not infected with plague, and showed that the vessel had been kept as free from rats as possible by the fumigation periodically carried out by the owners under my instructions. The last preceding fumigation had been done on 19th June, and it was reported by the manager that subsequent search had then discovered no rats and no carcases. During stay at Sydney the vessel usually visited two or three wharves, and habitually carried produce as well as empty sacks, crates, &c.; infected rats were being taken from time to time in the Darling Harbour area (*Cf.* the Table printed with the Diagram); and on the whole it seems most probable that the "Bega" acquired a plague-infected rat during her stay in port, with which G. was unfortunate enough to come into contact, although she was kept free from general infestation.

18. *Case O.*—C.G., f. aet. 37; wife of H.G. (Case N).—Mrs. G. had nursed her husband. She fell ill 26th June, and died at midnight on the 28th. On the 29th the medical man in attendance on her verbally reported his suspicion that she might have died of plague-pneumonia to the Department, and, as he had refused to certify to the cause of death, the Coroner, at my instance, directed removal of the body to a public dead-house for examination. It was dissected by the Government Pathologist and Second Government Medical Officer for Sydney (Dr. G. H. Taylor), who, among other details, reported of the lungs as follows:—There was a little recently effused lymph on the surface of the left pleura. An area of lung about the size of

a small orange in the left apex was consolidated, and the lung tissue around it was intensely congested and œdematous; below it there were numerous small pneumonic patches. The inferior lobe of the lung was much congested. In the lower lobe of the right lung there was a patch of consolidation similar in size and appearance to that in the left apex, which also had a zone of intensely-congested and œdematous lung-tissue. In this and the middle lobe there were numerous small pneumonic patches, and the remainder of the lung was intensely congested. The bronchial glands were soft and swollen, the bronchi deeply congested." In the laboratories it was found that films, cultures, and inoculation-tests made with lung tissue, all contained or yielded *B. pestis*, and it was noted that films prepared from the spleen furnished no evidence of plague-infection.

19. *Case P.*—S.R.M., f., æt. 39, married, housewife; residence, 39 Phillip-street, Balmain.—Attack sudden, 28th June, 7 a.m. Her case was notified, and she was visited, near midnight on the 29th. She was isolated at the Quarantine Station, North Head, 30th June, where she died during the evening of the same day. The body was examined by the Government Pathologist and Second Government Medical Officer for Sydney (Dr. G. H. Taylor), on 1st July, who reported that there was effusion of lymph over the left pleura, and a few minute hæmorrhages beneath it; there was grey hepatisation of the upper half of the superior lobe of the lung, the adjoining lung-tissue was œdematous and deeply congested; the inferior lobe contained numerous small pneumonic patches, and was intensely congested; the left bronchial glands were swollen and soft. The right lung was collapsed, but free from disease. At the laboratories, presence of *B. pestis* was identified in the lung-tissues by the usual methods. This patient's connection with the first of the preceding cases was intimate; she was with G. at times during his illness, and immediately before he died; she also viewed his body after death (24th or 25th). She was not with Mrs. G. after the latter had fallen ill on the 26th. The other occupants of her house were her husband and four children, aged from 17 to 3 years, all of whom were from time to time in her bedroom as long as she remained at home.

20. The mode of spread in primary plague-pneumonia is from person to person, through intermediary of saliva and of expectoration from the affected lungs. Usually this form is exceedingly contagious; many instances could be cited in which whole households have succumbed to it, or in which long trains of connected cases of it have occurred. Moreover, it is invariably, or almost always, fatal. And therefore, although isolation is but rarely necessitated by the circumstances in the bubonic and septicæmic forms of plague, it was essential to enforce it strictly and very promptly in connection with these cases of the pneumonic form. The diagnosis of C. G.'s case became known at 4.20 p.m. on 29th June; by 10 p.m. all the inhabitants of the G. house, together with many visitors to it, had been protected by subcutaneous injections of Yersin serum, and landed at the Maritime Quarantine Station, North Head, and the house had been quarantined in charge of the police. On that date also the M. household was similarly protected, and on the 30th was removed to the same place, the house itself, as well as another near it, being quarantined. On the same day a few more contacts were also sent down, and some persons whose connection with the cases was doubtful or slight were protected with injections of Yersin serum and placed under surveillance. Altogether 29 persons were isolated as contacts in connection with the G. and M. households; they were detained for five days and were then released. No further case occurred. It was ascertained that all three patients had very little cough; to this, I think, must be ascribed escape of their many young children, and of other persons who were freely exposed to them.

Destruction of Rats by Infection with Danysz's Rat-virus.

21. During past years three laboratory attempts have been made at the destruction of rats with imported strains of this organism, but without success. Dr. Danysz having arrived at Sydney to study a similar method of destroying rabbits, the opportunity was taken of making a further attempt under his supervision with virus which he had imported, had subsequently exalted to the requisite degree of virulence, and had been so kind as to place at my disposal. At his request a place was sought at which the results of its application in the field could be well-observed; and after a time, on suggestion of the Inspector-General of the Insane (Dr. Eric Sinclair, M.D.), I decided on the grounds of Gladesville Asylum, a large institution

for the insane, which consists of many ward, administrative, and farm buildings, separated from each other, and under close observation. The Acting Micro-biologist (Dr. R. J. Millard, M.B. Syd., D.P.H. Camb.) was directed to carry out the experiment, and he made the following report on its results:—

The virus used for this experiment was supplied by Dr. Danysz, who on 7th November last brought to the Laboratory from Broughton Island a pipette of blood from a rat which had died of the disease. This blood was on the same date sown into two tubes of ordinary broth, and on an agar slope, and incubated at 37 C. On 8th November, after twenty-four hours' incubation, the growth on agar proving to be a pure culture, one of the tubes of broth culture was distributed into six flasks—each 500 c.c.—of broth prepared according to Dr. Danysz' instructions, as follows:—

(1.) Take—

Lean beef, finely minced	500 grm.
Sodium chloride	5 „
Peptone (Witte)	1 „
Water	1,000 c.c.

Boil for two hours.

(2.) Decant the broth, and filter to remove the fat.

(3.) Mix the broth with the minced cooked meat. Render slightly alkaline to litmus paper by addition of caustic potash 10 % solution. Distribute into flasks. Sterilise.

November 8, 9.—The inseminated flasks were then incubated for twenty hours at 37 C.

On 9th November five of the flasks were taken by me to the Hospital for Insane at Gladesville, and baits were there prepared by soaking small cubes of stale bread in the mixture of broth and minced meat. The sixth flask was retained at the Laboratory to be administered to rats in cages, as controls.

Suitable spots on the hospital premises having been chosen by me, the placing of the baits was entrusted to an experienced rat-catcher (Allen) in the employ of the Department, who placed the baits in the evening, and examined them early next morning.

Details of this distribution were as follows:—

	Baits laid, 9/11/06.	Baits taken, 10/11/06.
Kitchen and surroundings	52	14
Stables	10	0
Boatshed and surroundings	36	31
Night-soil pit No. 1	14	6
„ „ No. 2	50	49
Piggery feed-room	12	2
Lower entrance to piggery (a roadway on rough stone "made" ground), ...	70	64
Totals	244	166

The "night-soil pits" are large trenches about 60 feet by 18 feet, and about 5 feet deep, in which night-soil from the hospital pail closets is deposited, mixed with earth and garden sweepings, there to remain until it is fit for use as manure. The pits are remote from the hospital buildings, in a large paddock forming part of the farm. At my visit during the afternoon I saw numerous rats here, and the sides of the pits were riddled with rat-holes.

The "lower entrance to the pig-yard" adjoins an excavation into which manure and other rubbish is tipped. Here the rats were even more numerous than at the night-soil pits, and could be seen in broad daylight running about among the stones.

The Assistant Superintendent of the Institution (Mr. Lewis) interested himself in the experiment, and undertook to have these spots kept under daily observation as to mortality amongst or diminution of rats, and to forward for examination at this Laboratory any dead rats that might be found.

Details of the rats fed as controls at the Laboratory are as follows :—

Rat No. 1,401 (*M. rattus*).

9 November, 1906—Fed on bread soaked in broth culture.
10 „ „ —Most of bread eaten.
12 „ „ —Escaped by gnawing through wire of cage.
14 „ „ —A rat similar to, and probably identical with, 1,401 trapped in Laboratory yard and killed.

P.M.—Liver enlarged, with some small areas of necrosis.
Culture from liver and spleen mixed, but Danysz' rat bacillus was isolated from each.

Rat No. 1,402 (*M. rattus*).

9 November, 1906—Fed in same way as No. 1,401.
10 „ „ —Most of bread eaten.
17 „ „ —Observed to be sick.
19 „ „ (Monday)—Dead at 9 a.m.

P.M.—Liver and spleen deeply congested ; large intestine inflamed ; heart dark and injected ; lungs normal.

Heart blood yielded a pure culture of the Danysz rat bacillus. Pipettes of this blood were used in preparing fresh batch of broth.

Rat No. 1,403 (*M. rattus*).

9 November, 1906—Fed in same way as No. 1,401.
10 „ „ —Most of bread eaten.
No apparent effect down to date of killing.
30 „ „ —Killed and examined. No evidence found of infection.

Rat No. 1,404 (*M. rattus*).

9 November, 1906—Fed in same way as No. 1,401.
10 „ „ —Most of bread eaten.
17 „ „ —Observed to be sick.
19 „ „ (Monday)—Dead at 9 a.m.

P.M.—Changes similar to those found in rat No. 1,402. Culture from heart blood was a mixed growth of the Danysz rat bacillus and a large sporing (putrefactive) bacillus.

Thus of the four control rats, two died in nine days, one suffered no ill effects of the feeding with infected broth, and the fourth was infected and would possibly have died of the infection if it had not been killed.

Four other rats were now fed and inoculated as follows :—

Rat No. 1,409 (*M. rattus*).

19 November, 1906—Fed with body of rat No. 1,404.
23 „ „ —Escaped from cage.
27 „ „ —Trapped and killed.

P.M.—Culture from heart blood, liver and spleen gave negative results.

Rat No. 1,410 (*M. rattus*).

19 November, 1906—Fed with body of rat No. 1,402.
4 December, 1906—No ill effects ; killed ; no evidence of infection.

Rat No. 1,411 (*M. rattus*).

19 November, 1906—Inoculated in the right thigh with heart blood of rat No. 1,402.
4 December, 1906—No ill effects ; killed ; no evidence of infection.

Rat No. 1.412 (*M. rattus*).

19 November, 1906—Inoculated in the right thigh with heart blood of rat No. 1,404.
4 December, 1906—No ill effects ; killed ; no evidence of infection.

At Gladesville the evidence of sickness amongst the rats was meagre. On 18th or 19th November a sick rat was seen by an attendant and killed at the night-soil pits, but through some misunderstanding this specimen was not sent to the Laboratory to be examined. I had made a careful inspection of the various spots two days before, on the 16th, and had found the rats then much in evidence, and apparently as numerous as ever.

On the 21st November, during a second distribution of baits, it was observed that many of the rat-runs at the night-soil pits had apparently not been recently used. Elsewhere no change was noticed. On the 22nd there were examined at the Laboratory seven rats (*M. decumanus*) from Gladesville, of which three had been found dead near the pig-yard entrance, and four had been trapped and killed. The three found dead were putrid, and a satisfactory examination could not be made. Of the trapped rats, three were apparently normal. The fourth, however, had the liver and spleen enlarged and congested, and a pure culture of the Danysz bacillus was obtained from the spleen.

On 21st November a second distribution of baits was made at Gladesville. The virus of these had been prepared in the same way as for the first distribution. A broth culture was made from the heart blood of rat No. 1,402 and this broth was sown into flasks of Dr. Danysz' medium, which were then incubated at 37° C. for twenty-four hours. In all 588 baits were distributed on this occasion as follows:—

	Baits laid, 21/11/06.	Baits taken, 22/11/06.
Night-soil pit No. 1	40	10
,, No. 2	60	25
,, No. 3	12	5
,, No. 4	60	20
Rubbish tip	100	90
Farm attendant's cottage	16	16
Lower entrance to pig-yard	300	200
Totals	588	366

On the same date corn, mixed with this infected broth, was fed to two rats in cages at the laboratory, details of which are as follows:—

RAT No. 1,413 (*Rattus*) and RAT No. 1,414 (*Rattus*).

21 December, 1906.—Fed on corn mixed with infected broth.

4 December, 1906.—No ill-effects have followed. Killed. No evidence of infection.

At Gladesville no more sick or dead rats were found. Inspections were made by me on 25th November, and 9th December, when I found at the lower entrance to the pig-yard the rats were still numerous, but saw none at the night-soil pits. On December 14th and 15th, Rat catcher Allen made a thorough inspection of these spots in the late evening and early morning, and found:—

At Nightsoil Pits.—Burrows deserted, and in many cases overgrown with cobwebs. Rats still resort to these pits to feed, as he saw from a rubble wall of a dam some 250 yards away, but they have apparently abandoned their burrows here.

At Lower Entrance to Pig-yard.—Many of the rat-runs show similar evidence of disuse. Rats are still numerous, but he believes that they come from a distance to feed here, and no longer live here in such numbers as before.

At the same time he trapped eight rats (*M. decumanus*) at these places, but none showed any evidence of infection.

Summary.—The experiment cannot be considered a satisfactory demonstration of the efficacy claimed for the Danysz Rat Virus.

The first batch of virus when fed to four control rats killed two in nine days, and infected a third, which unfortunately had to be killed, but the fourth rat, though he ate the virus, was not infected. Baits prepared with this first batch of virus distributed at Gladesville, infected some of the rats and probably caused some rat mortality, but evidently did not set up an epizoötic of any magnitude.

Attempts to hand on the disease by feeding the dead bodies of the infected rats, and cultures made from heart's blood of these, and even by injecting this blood, were uniformly unsuccessful, and it is doubtful if any result followed the second distribution of infected baits at Gladesville.

These negative results indicate a rapid loss of virulence, which must be obviated if this virus is to be of practical utility for rat destruction.

Note.—The following is a brief description of the bacillus under discussion:

Morphology.—A small cocco bacillus, with some long rod forms. Actively motile. Gram negative.

Culture.—On agar, produces a moist, creamy growth. Gelatine not liquified. In broth, a general turbidity and serum. On potato, a transparent, moist growth. Litmus milk becomes slightly acid in twenty-four hours, then alkaline. In peptone water no indol is produced. On glucose, acid without gas, and in glucose, neutral red fluorescence is produced. There is no fermentation of lactose or saccharose.

22. Plague rats were identified during 1906, on forty-eight premises, of which a large majority were as usual either wharves on the Darling Harbour wharf-line,

or business places within the Darling Harbour area. Down to the end of June all were taken on premises so situated; but at beginning of July some were found at the northern end of Macquarie-street, inland of the eastern margin of Sydney Cove (Circular Quay). They then began to be found about Miller's Point, as well as at fresh or old points on, or in the neighbourhood of, the Darling Harbour wharf-line. The last two of the year were found in George and in Market streets; but the only plague-rat found at a distant point was that taken at 118 Simmons-street Newtown, next to the house in which Case R. occurred. No further evidence of epizoötic plague was got in that district, where one or two blocks were systematically cleansed by the local authority acting under supervision of the experienced officers of this Department, after they had been "quarantined" (to fulfil legal requirements only) by Order-in-Council made on my recommendation.

23. The methods of prevention which were employed continued to be the same as in previous years.

J. ASHBURTON THOMPSON.

[One map.]

Sydney: William Applegate Gullick, Government Printer.—1907.

PLAGUE REPORT, 1906.

This Diagram shows the places at which plague-rats were taken, during 1906, by red spots consecutively numbered in accordance with the date on which the first was taken at each place. It also shows, by capital letters, the places at which twenty persons who had plague were employed, and, by lower-case letters surrounded with a circle, the places at which they resided. Cases in which the place of employment and of residence were one are distinguished by capital letters enclosed in a square.

The following table shows the places at which, and the first and last dates on which, plague-rats were taken: the entries are consecutively numbered in accordance with the dates on which they were first taken.

References to the twenty cases are inserted in the series in their order according to date of attack, and these are not numbered.

No.	Place.	Infected rodents taken.				First.	Last.
		Total.	M. Dec.	M. Rat.	M. Mus.		
1	Baltic Wharf	7	1	6	......	23-1-6	7-9-6
2	Federal Wharf, Melbourne Shed and Stores	10	3	4	3	8-2-6	12-12-6
3	North Coast Wharfs, Nos. 1 and 2	29	19	10	......	14-2-6	23-8-6
4	Stables, North-street, off Sussex-street	1	......	1	......	14-2-6	14-2-6
5	257A, Sussex-street	10	......	8	2	16-2-6	3-3-6
6	253, Sussex-street	9	......	9	......	26-2-6	17-3-6
7	205, Clarence-street	2	......	2	......	5-3-6	11-4-6
	Case C.—Attacked, 9-3-6.						
	Case E.—Attacked, 9-3-6.						
	Case B.—Attacked, 10-3-6						
	Case F.—Attacked, 10-3-6.						
	Case A.—Attacked, 12-3-6.						
	Case D.—Attacked, 12-3-6.						
	Case G.—Attacked, 12-3-6.						
8	346, Kent-street	1	......	1	......	12-3-6	12-3-6
9	191, Clarence-street	1	......	1	......	19-3-6	19-3-6
10	350, Kent-street	1	......	1	......	19-3-6	19-3-6
11	126, Sussex-street	22	......	18	4	29-3-6	2-4-6
12	207, Clarence-street	1	......	1	......	29-3-6	29-3-6
13	5, Wharf-street	1	......	1	......	3-4-6	3-4-6
14	Adelaide Wharf, No. 1	1	......	1	......	4-4-6	4-4-6
15	101, Sussex-street	1	......	......	1	6-4-6	6-4-6
16	See's Lane, rear of 346, Kent-street	1	......	1	......	9-4-6	9-4-6
17	9, Wharf-street	2	1	1	......	11-4-6	5-7-6
18	203, Clarence-street	1	......	......	1	18-4-6	18-4-6
	Case H.—Attacked, 7-5-6.						
19	201, Clarence-street	1	......	1	......	22-5-6	22-5-6
20	344, Kent-street	1	......	1	......	25-5-6	25-5-6
	Case I.—Attacked, 5-6-6.						
	Case K.—Attacked, 20-6-6.						
	Case L.—Attacked, 23-6-6.						
	Case M.—Attacked, 23-6-6.						
21	A.U.S.N. Wharfs, Nos. 1, 3, and 4	5	2	3	......	23-6-6	7-8-6
	Case N.—Attacked, 16-6-6.						
	Case O.—Attacked, 26-6-6.						
22	Union Wharf, Margaret-street, No. 2	1	......	1	......	28-6-6	28-6-6
	Case P.—Attacked, 29-6-6.						
	Case Q.—Attacked, 3-7-6.						
23	53-55, Macquarie-street North	2	2	......	......	3-7-6	4-7-6
	Case R.—Attacked, 10-7-6.						
24	Dalgety's Wharf, White Star No. 3	1	......	......	1	11-7-6	11-7-6
25	John Bridge's Store, Albert-street	1	1	......	......	11-7-6	11-7-6
26	H. Smith's Wharf, Brisbane No. 1	2	1	1	......	12-7-6	17-7-6
	Case S.—Attacked, 14-7-6.						
27	118, Simmons-street, Enmore	1	1	......	......	13-7-6	13-7-6
28	In Moore's Road, Miller's Point	2	......	2	......	16-7-6	[illegible]-8-6
29	Piggery, opposite North Coast Wharf No. 1	4	3	1	......	31-7-6	[illegible]-8-6
30	Walker's Wharf	2	2	......	......	31-7-6	2-8-6
31	Argyle Cut	1	......	1	......	3-8-6	3-8-6
32	61, Macquarie-street North	1	1	......	......	7-8-6	7-8-6
33	Hentsch's Bond, Miller's Point	4	......	4	......	9-8-6	24-8-6
34	119, Sussex-street	3	......	3	......	11-8-6	3-10-6
35	Brown's Wharf, No. 1	1	1	......	......	17-8-6	17-8-6
36	57, Macquarie-street North	1	1	......	......	18-8-6	18-8-6
37	123, Sussex-street	1	......	1	......	22-8-6	22-8-6
38	Market Wharf	1	......	1	......	28-8-6	28-8-6
39	15, Pier-street	27	......	1	26	30-8-6	10-9-6
40	17, Pier-street	1	......	......	1	6-9-6	6-9-6
41	Norddeutscher Lloyd Wharf, No. 3	1	1	......	......	7-9-6	7-9-6
42	Dalgety's Wharf, White Star No. 2, Woolloomooloo	1	1	......	......	10-9-6	10-9-6
43	In Macquarie-street, opposite No. 71	1	1	......	......	11-9-6	11-9-6
44	59, Macquarie-street	2	2	......	......	13-9-6	20-9-6
45	Pyrmont Bridge Wharf	1	......	1	......	14-9-6	14-9-6
	Case T.—Attacked, 1-10-6.						
46	Saywell's Wharf, Dawes' Point	1	1	......	......	5-10-6	5-10-6
47	387, George-street, City	1	......	1	......	13-10-6	13-10-6
	Case U.—Attacked, 22-12-6.						
48	47A, Market-street, City	1	1	......	......	29-12-6	29-12-6

PREPARED FOR THE DEPARTMENT OF PUBLIC HEALTH.

MAP OF THE

CITY OF SYDNEY

AND

ADJACENT MUNICIPALITIES.

THIS DIAGRAM SHOWS THE PLACES AT WHICH PLAGUE-RATS WERE TAKEN DURING 1906, THE PLACES AT WHICH PERSONS WHO HAD PLAGUE WERE EMPLOYED, AND THE PLACES AT WHICH THEY RESIDED.

EXPLANATORY NOTES.

Places at which plague-rats were taken, consecutively numbered in accordance with the date on which the first was taken at each place.	*shown thus*	22-●
Places at which persons who had plague were employed	*do*	A
Places at which persons who had plague resided	*do*	ⓐ
Places at which persons who had plague both resided and were employed	*do*	B

W. A. Gullick, Government Printer, Sydney, N.S.W.

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LEGISLATIVE ASSEMBLY.
NEW SOUTH WALES.

REPORT

OF THE

BOARD OF HEALTH

ON

PLAGUE IN NEW SOUTH WALES, 1907.

On a Seventh Outbreak of Plague at Sydney, 1907.

BY J. ASHBURTON THOMPSON, M.D., D.P.H., PRESIDENT,
Chief Medical Officer of Government.

On an Outbreak of Plague at Kempsey, Macleay River, 1907.

BY R. J. MILLARD, M.B., CH.M. (SYD.), D.P.H. (CAMB.),
Assistant Medical Officer of Government and Acting Microbiologist.

Printed under No. 9 Report from Printing Committee, 15 October, 1908.

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1908.

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REPORT OF THE BOARD OF HEALTH

ON A

Seventh Outbreak of Plague at Sydney, 1907.

By J. ASHBURTON THOMPSON, M.D., D.P.H., President,

Chief Medical Officer of Government.

21st September, 1908.

In 1906, attack occurred in the last case on 22nd December, and the last plague-rat was taken on 29th December. In the year under review attack occurred in the first case on 7th January, 1907; the first rat in which plague was identified was taken on 10th January, the last on 21st September. Attack in the last case occurred on 29th December, 1907; but plague-rats in number were discovered in connection with it, and with another which preceded it (attacked 27th December) as soon as search had proceeded sufficiently, namely, on 2nd January, 1908.

2. Forty-seven cases* occurred during 1907, of which 16 ended fatally. Five of the patients were Chinese, of whom 3 were of Chinese birth, while 2 were of Chinese parentage, but born at Sydney. Four of the 5 died, 2 of them of primary plague-pneumonia. Of the 16 fatal cases 5 were notified only after death. Three of the bodies were examined, but the other 2 had been buried before their cases were brought to light by occurrence of a third case connected with them. The fatality of the disease was thus 34 per cent. on the whole number; but if the Chinese are omitted then 28·5 per cent. on whites only.

3. The clinical forms of the disease which were presented by the 47 cases were as follows:—Bubonic, 39 (in Case 11 there was merely some fulness of the left cervical region, but no defined bubo; in Case 15 there was some fulness and tenderness in Scarpa's triangle, but no defined bubo); Septicæmic, 6: Nos. 5 (d)†, 8 (d), 14 (d), 16 (d), 22 (d), 38 (d) (in Case 5 (d) glands in the left cervical region became tumefied a few hours before death early on the fifth day); Primary plague-pneumonia, 2: Nos. 6 (d), 7 (d).

Table I.—Showing the situations in which the buboes occurred in the 39 Bubonic cases.

Left femoral chain, 14 (Nos. 1, 2, 3, 4, 9, 23, 28, 29, 30, in which two glands could be distinguished, 32, 39, 42 (d), 45, and 46).

Right femoral chain, 9 (Nos. 10, 15, in which was some fulness and tenderness in Scarpa's triangle, no defined bubo, 24 (d), 25, 33, 26, 40 (d), 41, and 44 (d).

Right inguinal chain, 6 (Nos. 12, 13, 17, 18, 19, 34).

Left inguinal chain, 4 (Nos. 21, 27, 35 (d), and 43, in which was also some enlargement of the corresponding glands on the left side).

Right femoral and inguinal, 1 (No. 20).

Left femoral and inguinal, 2 (Nos. 26 (d) and 47).

Right femoral and left cervical, 1 (No. 37, d).

Left cervical, 1 (No. 11; some fulness, no defined bubo; recovered).

Femoral, inguinal, and mesenteric (necropsy), 1 (No. 31, d).

4. In a large majority of the cases attack was so sudden that the patient could name the hour at which illness supervened on a state of ordinary health. This was quite clearly the case in 27 of them, which remained after deduction of 4 concerning which no account was forthcoming; 9 in which the onset was gradual (Nos. 2, 4, 11, 17, 19, 21, 27, 42, 44); and 7 in which suddenness could not be determined because illness was first perceived on awaking at the usual time in the morning. In these cases a rigor was often the first symptom of illness, and it was either accompanied, or immediately followed by headache, to which vertigo was often added, together

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* The details of each of these cases will be found in Appendix A, p. 31. † (d) = died.

with nausea. Occasional vomiting often followed nausea, and, when it did so, usually passed off in 24 hours. When the attack was gradual, lassitude was sometimes the first symptom, and sometimes general pains about the body, with preference for the back or loins; sometimes there was a longish term of ill-feeling which could not be more particularly described. But in some of the cases which may be considered as having begun gradually, pain in the gland in which the primary bubo developed later was the first symptom observed, as is shown more fully below.

5. The time-relation between reaction in the gland which was afterwards the seat of the primary bubo, and the onset of constitutional symptoms, was as follows in the 32 cases, of which the required details could be learned with certainty (see Appendix B, p. 43). Pain in the gland preceded constitutional symptoms, by from one or two to several hours, in 8 instances. Pain in the gland was noticed at the same time as constitutional illness in 8 others. Pain in the gland was not observed until some hours after the constitutional symptoms had declared themselves (maximum 48 hours) in 17 cases. From analogy it seems likely that these variations are, in great measure, a matter of observation; for when a wound becomes septic in the hand of one who knows the risk, deep pressure detects tenderness in the axilla although no discomfort was felt there before search. Most likely, therefore, some reaction attended by tenderness always occurs in the gland which the inoculated virus first reaches, but is often overlooked by the patient because pain is usually not felt till a later time. Perhaps the evidence may be interpreted as follows:—The bacillus (which but seldom causes reaction at the place of inoculation), may flourish in the gland, and produce toxins which may be absorbed in important amount before any local reaction has been manifested by pain or swelling—in which case the bubo appears as a topical effect of the toxins; on the other hand, the topical effect may be prominent from the beginning, and may be marked before absorption of toxins in amount sufficient to cause constitutional illness has taken place; lastly, as appears from Case 19 (see Appendix A, as well as from Case E, Report 1906, p. 2), a well-marked topical effect may be produced, and yet may remain the only recognisable sign of infection. These observations have interest in relation to the suggestion which has been made (though on insufficient evidence) that infection commonly occurs by way of the digestive tract, and causes a constitutional illness; the bubo, as well as the other minor alterations of the lymphatic ganglia in general, being regarded as selective results of the general infection.

6. Sixty-nine cases were reported for diagnosis during the year, all of which turned out not to be cases of plague; 51 by medical men, 17 by the police, by friends, or by the patients themselves. The 51 included cases of pneumonia, enteric, septicæmia, rheumatism, diphtheria, meningitis, and cellulitis; but 31 of them presented enlarged glands in one or other region of the body, 15 of them in the femoral or inguinal chains. As a rule there was little difficulty in tracing the glandular swellings to some usual cause; but 2 of these cases were clinically indistinguishable from plague, and it was only as the result of bacteriological examination that one of them was found to be caused by a diphtheroid bacillus, the other by a Gram-positive diplococcus, and that the negative diagnosis was established. Similar experiences in former years had been nearly the same. Thus, in each of the years 1901–6 cases were reported for diagnosis in the following numbers:—11, 103, 12, 15, 34, and 23, among which the diseases mentioned above were recognized. Only 4 or 5 ambulatory cases have been met with since plague first appeared, of which two have just been cited (par. 5), and, as has been noted in the Report for a former year, we have seen nothing of *pestis minor*.

7. The total number of rats and mice destroyed during the year was—of rats, 62,012; of mice, 28,363; total, 90,375. Payment was made to the public for 42,635 rats, and for 16,119 mice, total 58,754, brought in between 13th February and 31st December; none of these were examined.

8. The number submitted by the Intelligence Staff during the whole year was, consequently, of rats 19,377, of mice 12,244, total 31,621, all of which were examined; there were also 2 water-rats (hydromys) and 3 domestic cats, of which none were infected.

9. The several species occurred in the following numbers, and proportions expressed as percentages on the whole number submitted (31,621):—*M. decumanus*, 8,628 (27·2 per cent.); *M. rattus*, 10,749 (33·9 per cent.); *M. musculus*, 12,244 (38·7 per cent.).

10.

DIAGRAM 1.

This Diagram shows the places at which plague-rats were taken, by red spots consecutively numbered in accordance with the date on which the first was taken at each place. It also shows, by capital letters, the places at which thirty-eight persons who had plague were employed, and, by lower-case letters surrounded with a circle, the places at which they resided. Cases in which the place of employment and of residence were one are distinguished by capital letters enclosed in a square.

The following table shows the places at which, and the first and last dates on which, plague-rats were taken: the entries are consecutively numbered in accordance with the dates on which they were first taken.

References to the thirty-eight cases are inserted in the series in their order according to date of attack; they are numbered in order of date of notification.

No.	Place.	Rodents taken.				Total.	First.	Last.
		M. Dec.	M. Ratt.	M. Alex.	M. Mus.			
	1. Case A.—Attacked, 7-1-7.							
	6. Case B.—Attacked, 9-1-7.							
1	Bank Court lane, off King-street, City	3	1	......	......	4	10-1-7	15-1-7
2	Federal Wharf, No. 1	2	6	......	1	9	11-1-7	3-8-7
3	Lockley's Wharf	......	1	......	......	1	14-1-7	......
4	345A, Sussex-street, City	1	10	......	......	11	14-1-7	14-2-7
	7. Case C.—Attacked, 15-1-7.							
	2. Case D.—Attacked, 17-1-7.							
	10. Case E.—Attacked, 18-1-7.							
	5. Case F.—Attacked, 21-1-7.							
5	Surrey Hotel, 153, King-street, City	......	1	......	......	1	21-1-7	......
	4. Case G.—Attacked, 22-1-7.							
	8. Case H.—Attacked, 22-1-7.							
	3. Case I.—Attacked, 23-1-7.							
	9. Case J.—Attacked, 25-1-7.							
	13. Case K.—Attacked, 25-1-7.							
	14. Case L.—Attacked, 26-1-7.							
	11. Case M.—Attacked, 27-1-7.							
	12. Case N.—Attacked, 27-1-7.							
6	Civic Club, 175, Pitt-street, City	3	......	......	......	3	28-1-7	9-2-7
7	382, George-street, City	1	......	......	......	1	28-1-7	......
8	Empire Hotel, 101-103, Pitt-street, City	1	......	......	1	2	29-1-7	9-2-7
9	Town-hall Yard, City	......	1	......	......	1	30-1-7	......
10	Royal Standard Hotel, 228, Castlereagh-street, City	......	17	......	......	17	30-1-7	14-2-7
11	94, King-street, City	4	......	......	2	6	30-1-7	14-2-7
12	279, Pitt-street, City	1	......	......	......	1	31-1-7	......
13	Metropolitan Hotel, 155, King-street, City	1	......	......	......	1	1-2-7	......
14	119, Bathurst-street, City	......	1	......	......	1	2-2-7	......
15	Bulletin-lane, City	......	1	......	......	1	2-2-7	......
16	City Tattersall's Club, Pitt-street, City	1	1	......	......	2	4-2-7	5-2-7
17	349-355, George-street, City	......	1	......	......	1	5-2-7	......
	15. Case O.—Attacked, 6-2-7.							
	16. Case P.—Attacked, 6-2-7.							
	17. Case Q.—Attacked, 6-2-7.							
18	412, George-street, City	1	......	......	......	1	8-2-7	......
19	Stables at 42, Campbell-street, City	1	......	......	......	1	9-2-7	......
	19. Case R.—Attacked, 9-2-7.							
	20. Case S.—Attacked, 9-2-7.							
	18. Case T.—Attacked, 10-2-7.							
	22. Case U.—Attacked, 12-2-7.							
20	Hawkesbury Wharf	......	2	......	......	2	13-2-7	29-7-7
	21. Case V.—Attacked, 13-2-7.							
	23. Case W.—Attacked, 14-2-7.							
21	53-55, Market-street, City	......	1	......	......	1	14-2-7	......
22	173, Pitt-street, City	......	1	......	......	1	14-2-7	......
23	388-390, Sussex-street, City	......	1	......	......	1	14-2-7	......
	26. Case X.—Attacked, 15-2-7.							
24	White Heart Hotel, King and Clarence streets	1	......	......	......	1	15-2-7	......
	24. Case Y.—Attacked, 16-2-7.							
	25. Case Z.—Attacked, 16-2-7.							
	27. Case AA.—Attacked, 20-2-7.							
25	Her Majesty's Restaurant, Pitt-street	1	......	......	......	1	20-2-7	......
	28. Case BB.—Attacked, 21-2-7.							
26	Hart's Marine Café, Circular Quay	......	3	......	......	3	21-2-7	15-3-7
27	Pyrmont Bridge Wharf	1	3	2	......	6	22-2-7	27-6-7
	30. Case CC.—Attacked, 1-3-7.							
28	City Chambers, 243, Pitt-street, City	......	......	......	1	1	1-3-7	......
	29. Case DD.—Attacked, 3-3-7.							
	31. Case EE.—Attacked, 4-3-7.							
29	131, Pitt-street, City	1	......	......	......	1	4-3-7	......
30	Albion Wharf, No. 1	1	1	......	......	2	4-3-7	5-9-7
31	116, King-street, City	1	......	......	......	1	4-3-7	......
32	117½, Bathurst-street, City	......	1	......	......	1	5-3-7	......
	33. Case FF.—Attacked, 7-3-7.							
33	Nicoll's Wharf	......	1	......	......	1	[illegible]-3-7	......
	32. Case GG.—Attacked, 9-3-7.							
34	Pyke-lane, off Market-street, City	......	1	......	......	1	[illegible]-3-7	......
35	No. 5 Jetty, Circular Quay	......	1	......	......	1	16-3-7	......
	34. Case HH.—Attacked, 16-3-7.							
	36. Case II.—Attacked, 16-3-7.							
36	Bond Store, Federal Wharf, No. 1	1	......	......	1	2	18-3-7	26-3-7
37	Rowan's Bond, No. 9, Pitt-street, City	......	1	......	......	1	18-3-7	......
38	Harbour Trust Office, Circular Quay	......	2	......	......	2	19-3-7	......
	35. Case JJ.—Attacked, 18-3-7.							
39	A.U.S.N. Wharf, No. 3	1	1	......	1	3	21-3-7	9-5-7
	37. Case KK.—Attacked, 21-3-7.							
	38. Case LL.—Attacked, 22-3-7.							
40	Federal Store No. 4, rear Albion Wharf	......	3	......	1	4	22-3-7	27-3-7
41	Market and Illawarra Wharf	2	1	......	......	3	22-3-7	20-8-7
42	Federal Wharf, No. 2	6	2	......	1	9	22-3-7	5-10-7
43	132, Pitt-street, City	1	......	......	1	2	23-3-7	28-3-7

(Continued on Diagram 2.)

PREPARED FOR THE DEPARTMENT OF PUBLIC HEALTH.

MAP OF THE

CITY OF SYDNEY

AND

ADJACENT MUNICIPALITIES.

THIS DIAGRAM SHOWS THE PLACES AT WHICH PLAGUE-RATS WERE TAKEN DURING 1907, THE PLACES AT WHICH PERSONS WHO HAD PLAGUE WERE EMPLOYED, AND THE PLACES AT WHICH THEY RESIDED.

EXPLANATORY NOTES.

Places at which plague-rats were taken, consecutively numbered in accordance with the date on which the first was taken at each place.	*shown thus*	●—22
Places at which persons who had plague were employed	*do*	A
Places at which persons who had plague resided	*do*	ⓐ
Places at which persons who had plague both resided and were employed	*do*	B

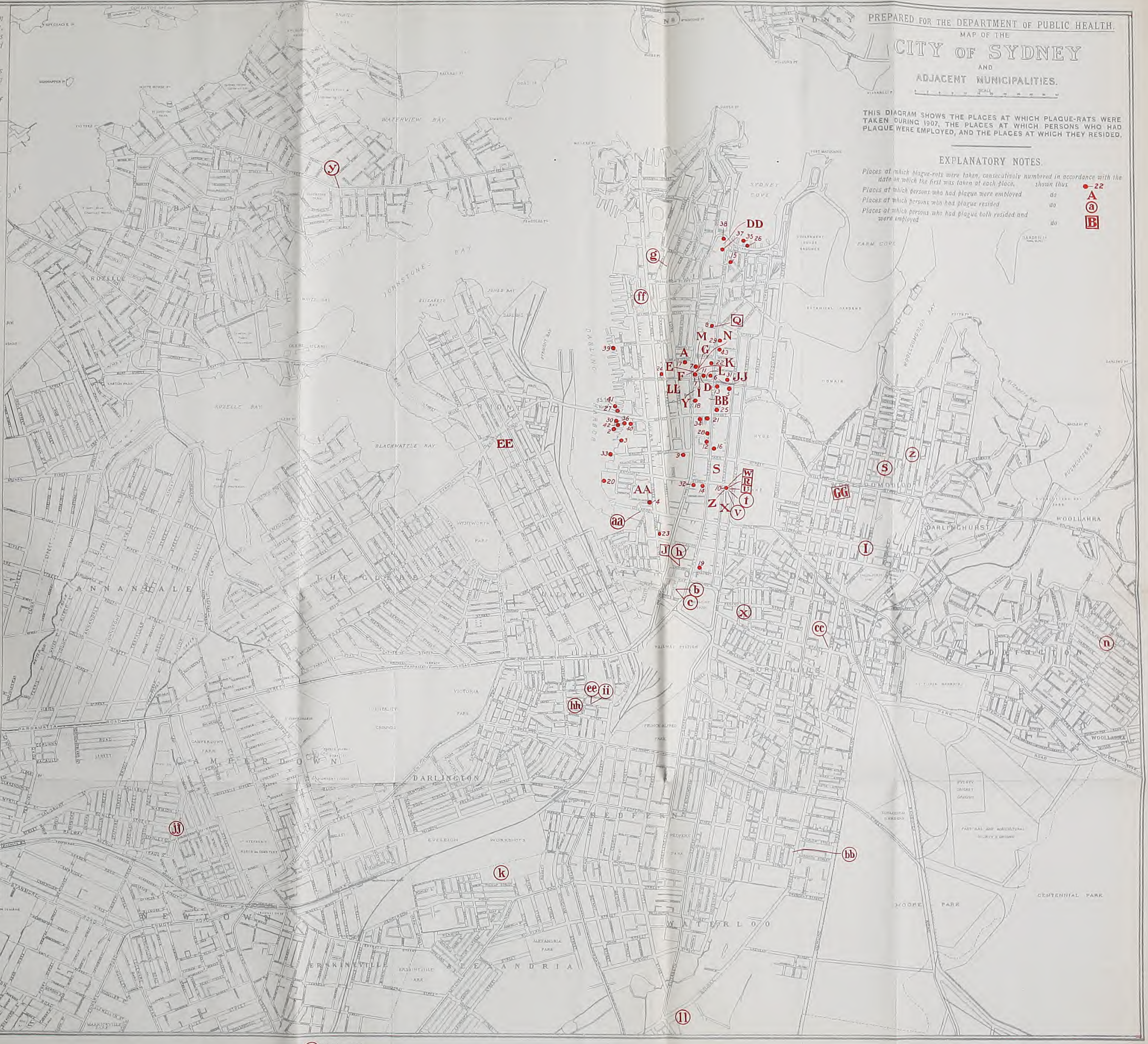

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DIAGRAM 2.

THIS Diagram shows the places at which plague-rats were taken, by red spots consecutively numbered in accordance with the date on which the first was taken at each place. It also shows, by capital letters, the places at which nineteen persons who had plague were employed, and, by lower-case letters surrounded with a circle, the places at which they resided. Cases in which the place of employment and of residence were one are distinguished by capital letters enclosed in a square.

The following table shows the places at which, and the first and last dates on which, plague-rats were taken: the entries are consecutively numbered in accordance with the dates on which they were first taken.

References to the nineteen cases are inserted in the series in their order according to date of attack; they are numbered in order of date of notification.

No.	Place.	Rodents taken.				Total.	First.	Last.
		M. Dec.	M. Ratt.	M. Alex.	M. Mus.			
44	20, Druitt-street, City	......	2	......	......	2	6-4-7	10-4-7
	39. CASE MM.—Attacked, 7-4-7.							
	40. CASE NN.—Attacked, 8-4-7.							
45	City Milling Co., off foot of Druitt-street, City	......	1	......	2	3	9-4-7	15-4-7
46	S.S. "Ramornie," North Coast Wharf, No. 2	......	1	......	......	1	9-4-7	......
	41. CASE OO.—Attacked, 10-4-7.							
47	Old China Wharf, Miller's Point	......	4	......	......	4	12-4-7	16-4-7
	42. CASE PP.—Attacked, 13-4-7.							
	43. CASE QQ.—Attacked, 14-4-7.							
48	John Bridge's Store, Albert-street, City	1	......	......	......	1	18-4-7	......
49	407½, Kent-street, City	......	5	......	......	5	19-4-7	23-4-7
50	Day-street, near A.U.S.N. Wharf, No. 4	......	1	......	......	1	20-4-7	......
51	Gas lane, off Kent-street, City	......	1	......	......	1	23-4-7	......
52	Jenkins-street, City (vacant land)	......	1	......	......	1	25-4-7	......
53	Grafton Bond "G," rear of	......	3	......	......	3	25-4-7	......
54	118-120, Sussex-street, City	......	5	......	......	5	1-5-7	26-6-7
	44. CASE RR.—Attacked, 5-5-7.							
55	Leichhardt and Pyrmont Wharf	1	1	......	......	2	6-5-7	28-5-7
56	Dalton's Wharf	......	1	......	......	1	6-5-7	......
57	Kent-street, outside City Council's Block-yard	......	1	......	......	1	8-5-7	......
58	Newcastle and Hunter River Wharf	......	1	1	......	2	9-5-7	16-7-7
59	189A, Sussex-street, City	......	1	......	......	1	9-5-7	......
60	199, Pitt-street, City	1	......	......	......	1	14-5-7	......
61	A.U.S.N. Wharf, No. 4	......	1	2	......	3	15-5-7	26-6-7
62	Belmore Markets	......	2	......	......	2	17-5-7	......
63	North Coast Wharf, No. 1	14	2	7	1	24	18-5-7	14-9-7
	45. CASE SS.—Attacked, 19-5-7.							
64	North Coast Wharf, No. 2	3	......	......	2	5	29-5-7	6-7-7
65	Central Wharf, No. 2	......	1	......	......	1	10-6-7	......
66	S.S. "Tomki," North Coast Wharf, No. 1	......	......	1	......	1	11-6-7	......
67	Flood's Wharf, No. 1	......	1	......	......	1	11-6-7	......
68	Warburton's Wharf	......	......	......	3	3	27-6-7	21-10-7
69	Parbury's Wharf, No. 1	1	......	......	......	1	28-6-7	......
70	153, Sussex-street, City	......	......	5	1	6	2-8-7	29-8-7
71	Goldsbrough (late Mort's) lane	......	2	......	......	2	15-8-7	19-8-7
72	137, Sussex-street, City	......	2	12	......	14	21-8-7	27-8-7
73	168, Sussex-street, City	......	......	5	......	5	26-8-7	9-9-7
	Total rodents...	58	107	35	19	219		
	46. CASE TT.—Attacked, 27-12-7.							
	47. CASE UU.—Attacked, 29-12-7.							

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EXPLANATORY NOTES.

Places at which plague-rats were taken, consecutively numbered in accordance with the date on which the first was taken at each place,	*shown thus*	●—22
Places at which persons who had plague were employed	*do*	A
Places at which persons who had plague resided	*do*	ⓐ
Places at which persons who had plague both resided and were employed	*do*	B

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10. The number in which plague was identified was 219, namely—*M. decumanus*, 57; *M. rattus*, 143; *M. musculus*, 19. The percentages of infected specimens to the total of each species was ·66, 1·3, and ·15 respectively. I have already remarked that mice seem to be less susceptible than rats (Report 1904, par. 13); and that such evidence as I have been able to collect on the point goes to show that plague in the mouse is not a cause of plague in man (see Appendix G, par. 25, p. 64).

11. Table II shows the number of rats collected in twelve consecutive calendar months, the number of males and of females, and the number and percentage of pregnant females, of each species:—

Table II.—Sydney, 1907–8.

	M. decumanus.					*M. rattus.*				
	Total.	M.	F.	Pr.	Per cent.	Total.	M.	F.	Pr.	Per cent.
1908.—January	1,058	726	332	48	14·4	927	514	413	68	16·4
February	1,369	961	408	55	13·4	952	582	370	65	16·4
March	763	426	337	39	11·5	748	413	335	51	15·2
April	609	365	244	25	10·2	613	338	275	35	12·7
May	852	533	319	16	5·3	1,161	693	468	60	12·8
1907.—June	584	381	203	18	8·8	1,053	743	310	48	15·4
July	374	215	159	16	10·	490	265	225	34	15·1
August	494	279	215	34	15·8	702	437	265	54	20·3
September	422	252	170	27	15 8	639	373	266	53	19·9
October	447	273	174	37	21·2	984	612	372	91	24·4
November	587	382	205	41	20·	741	504	237	35	14·7
December	550	345	205	27	13·1	477	282	195	26	13·3

12. Broadly, the table shows that the percentage of pregnant rats fell from January to May, when the lowest percentage occurred, that it rose from May to October, when the highest percentage occurred, and that it had fallen again by December to a point a little below the level of the initial point in the preceding January. For *rattus*, that initial point was higher than for *decumanus* by 2, but the terminal point in December was lower by one; and the proportion of pregnancies in that species was much higher both in May and in October. Some minor differences in both series of percentages being neglected, it may be said that here both species bred during the whole year, that there was slightly greater activity in this direction about September and October (Spring), that *decumanus* appears to have been the more susceptible to some hindering influence which made itself felt about May and June, and, on the whole, that *rattus* showed itself more fertile than *decumanus*.

13. The premises on which infected rats and mice were found numbered 73, and may be classified as follows:—Wharves 21, bonds 4, small steamers alongside, 2, dwellings 2, shops 35, open places 9. *M. decumanus* only was found in 18 of them, *M. rattus* only in 42, *M. musculus* only in 2, and both species of rats together, in 11.

14. Past records, and that for the present year, do not afford evidence that either species usually begins to suffer before the other. In 1903 infected specimens of *M. decumanus* were taken 5 weeks, and in 1905, 8 weeks, before any infected *M. rattus* was found; in 1904 and 1906, infected *M. rattus* was found 5 weeks and 6 weeks before infected *M. decumanus*; while in 1907 the first infected rats brought in were of both species. On 6 of the 11 premises on which both species were found in 1907, infected *M. decumanus* was first found, and the intervals after which infected *M. rattus* was first found were 5, 7, 9, 19, 27, 49, and 53 days. In the 5 houses where the contrary was the case, the intervals were 1, 21, 22, 184, and 187 days. So that it does not appear from these records that there is here any other than a casual connection beween plague in the one and in the other species. As regards individual premises, many of the intervals suggest re-invasion, for all on which infected rats (or mice) were found, were at once subjected to rigorous search, cleansing, and repair. The same methods were employed by the same staff on practically the same areas in all the years just mentioned.

15. It should be noted here that *reinvasion* and *infestation* do not necessarily connote similar structural states, nor does re-invasion indicate failure of the practicable means of exclusion. In our case the rats find harbourage under

ill-constructed wharves, and food on the small foreshores such wharves leave exposed. Thence they enter buildings which have been rendered insusceptible of infestation by occasionally-opened doors, and by obscure passages which have escaped notice in course of protecting all known openings by wire-netting or other means. But such incursions are of slight importance, and are to be diminished by the costly works necessary to destroy their harbourage under the wharves referred to, in which, as well as elsewhere, they live and breed (see par. 62 below).

16. It is interesting to note in this connection that similar methods, in part borrowed from the work done towards restraint of rats, have been found effectual as against rabbits. Wire-netting of paddock fences had long been adopted as the best defence of grass, and it had been supplemented by the scattering of mineral poisons. Down to a late date this was the best plan known, but it was not completely successful until systematic destruction of harbourage was added. Then it was found that runs could be kept free, at cost, it is true, of great labour at the beginning, but with little trouble in subsequent years.

17. Table III shows the numbers of the three species which were collected and examined month by month in the years 1906 and 1907 :—

TABLE III.—SYDNEY, 1906 AND 1907.

	1906.			1907.		
	D.	R.	M.	D.	R.	M.
January	782	594	773	948	1,205	983
February	1,143	769	791	1,666	1,726	1,658
March	1,409	1,362	1,485	1,308	1,108	1,811
April	570	753	1,095	719	821	1,389
May	691	470	1,094	529	803	975
June	779	851	1,180	584	1,053	848
July	547	556	1,075	374	490	908
August	473	702	986	494	702	1,092
September	594	719	1,103	422	639	709
October	559	602	601	447	984	578
November	790	616	557	587	741	891
December	938	700	738	550	477	402
	9,275	8,694	11,478	8,628	10,749	12,244
		29,447			31,621	

18. In both years the number of rats collected during February and March was much greater than in any other month. I do not know of any circumstance to account for this variation, but possibly it stands in relation to the greater percentage of pregnancies observed in the preceding October. However, the numbers collected during December and January do not point definitely in that direction.

19. The numbers of the several species taken, the numbers found to be infected, and consequently the percentages struck with them, have, in my opinion, a significance which is strictly local (even within the infected area). They show only that there the three species existed and suffered; not in what proportion to each other they existed, nor to what extent they suffered. For reasons already given (Report, 1903, pars. 13–15) they stand in primary relation to the methods of search, not to the phenomena of the epizoötic. It is their smallness alone which allows this point to emerge and to be clearly seen, for if they were greatly multiplied they would convey an impression of approximate completeness by mere size, and, consequently, would assume the aspect of fact. If they were interpreted accordingly there would be risk of error. However, when the infected specimens have been correlated with the neighbourhoods in which they were gathered they do show with more or less exactness the area over which the epizoötic extended.

20. It is especially useful and necessary to study the circumstances which surrounded the occurrence of associated cases, of which seven groups were observed during the year. The details of each group are given below. It will be seen that the circumstances differed widely. The Bank Court (9 cases) and the Standard

Hotel (7 cases) groups are instances of association by locality alone. The Campbell-street group (4 cases) exemplifies association by contact, the first and second cases having exhibited the form of primary plague-pneumonia, but the third, in which there had been intimate association with the second, the septicæmic form; the source of the infection in the fourth case is more doubtful. The Marrickville group (2 cases) is given as a further instance of transport of the infection with fodder to a distance of several miles from the infected area, and as further evidence of the indirectness of the channel by which the infection is communicated from rat to man. Lastly, the Zetland (2 cases), Chippendale (2 cases), and the Yule-street (3 cases) groups have especial interest; they should be considered in connection with Cases L and M, Report 1906, par. 14.

21. As regards the last-mentioned groups, the sources from which the secondary cases took their infection were, most probably, the primary cases, all of which had resulted from infection taken at the centre of the city. But the way in which the infection was communicated to the secondary cases must have been indirect; for while the incubation-period of plague, in my experience (and in general experience) rarely extends over 5 days, and is much more commonly limited to 3 days or less, all the secondary cases in these groups had been out of possible contact with their primaries for more than 5 days before the dates of their attack. The choice between the indirect channels of communication is limited to two; namely, deposited infection, and infection transported and communicated by the flea. As regards deposited infection, after having noted that neither infected man nor infected animal had existed on the premises since a date anterior to the dates of infection by several days, nor, as regards animals, had at any time existed, it can be said that this source is excluded by our earliest observations (Report 1900), which have been corroborated by all subsequent experience; plague does not spread by deposited infection.

22. The flea, acting as a living intermediary, alone remains. A preliminary question in relation to this channel is whether the evidence which excludes deposited infection as a cause is not of such a nature as to exclude also communication from man to man by the flea; but the conditions necessary to enable the flea to act as a carrier from man to man are not frequently fulfilled in civilised life. The disease in the rat is almost always a septicæmia, it is almost always fatal, and that animal carries many fleas as long as illness lasts. But the contrary is the case with man in this country. Usually he and his dwelling have not many fleas, and usually the disease does not assume the septicæmic form with him, or does so as a rule only for a short time before death when, most often, patients have already been removed to hospital. If, however, man be infested with fleas, if his disease do assume the septicæmic form, and if he do die at home, then fleas which bite him are likely occasionally to receive the infection from him, and, as has now been experimentally shown, can retain their power of communicating it during several days. This I inferred in 1902 must be the case (see Report on the Second Outbreak, dated 31st July, 1903, par. 300). The necessary conditions were fulfilled in these groups.

23. Two further points must be considered in connection with the infection of these secondary cases. First, as to the kinds of fleas which may have acted as intermediaries between the patients, and the likelihood that they were present in the three houses. The Plague Research Committee in India, under direction of Dr. Charles J. Martin, F.R.S., has shown (1906) that the infection is commonly communicated between the lower animals by the species *Loemopsylla cheopis* (Rothschild). This is the common rat-flea in tropical and sub-tropical climates, and in this part of Australia. But as there were very few rats on any of the premises now under consideration (it may almost be said there were none at all), it seems unlikely that this species can have been concerned. Other species, however, possess the same power. Thus, *P. irritans* (the man-flea) bites the rat, and can even live upon it as a casual parasite; and if it has fed on a septicæmic plague rat, it can communicate the infection to healthy animals.* The same has also been shown for *P. canis* and *P. felis.*† The question whether fleas which could have communicated the disease between human beings were present in these three cases may be answered in the affirmative with probability, therefore, notwithstanding assumed absence of the species *L. cheopis.*

24.

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* *Journ. of Hygiene* (1907), p. 413, Report of the Plague Research Committee (3 successful trials out of 38); and Verjbitski, *ibidem* (1908), p. 180. † Verjbitski, *ub cit.*; (the Committee failed in 27 experiments with *P. felis.*)

24. The second point is, whether, after all, the flea is the prime cause of epidemic prevalences of plague. That it is the channel of communication between the lower animals has been amply and conclusively demonstrated by the Committee and by others; but they have not shown, and, in default of direct experiments which cannot be performed, they could not show, that it is the common carrier from animal to man. My own unhesitating opinion is that the flea is also the ordinary channel of communication between animal and man, and it is deduced from observations in the field which were first published in July, 1903, in the Report on the year 1902. Those observations, I think, still constitute the best evidence that the flea is the common cause of the infection of man; and they have been so often overlooked that I venture to draw attention to them once more in this place (see Appendix E, p. 46, where paragraphs 262–70 are reprinted). Much additional evidence of the same kind has since accrued from further observation at Sydney. The original 12 cases were selected from a series of 139, which constituted the outbreak of 1902, with a meticulous care for exactness which need not now be quite so closely observed; and with that reservation 18 cases which afford testimony of the same kind can be chosen from the present much briefer series of 47 cases, to go no further.

THE BANK COURT GROUP.

25. This group was formed of the nine cases mentioned below; they occurred in persons whose sole connection with each other was resort to this locality in which they were employed; all of them dwelt each in his own house at various distances, which were, for the most part, considerable.

TABLE IV.

W.D.S.	Case	2 (D)—	Attacked	17	January,	at	80 King-street (Sargent).
V.B.	,,	10 (E)	,,	18	,,	,,	390 George-street (Sargent).
V.M.S.	,,	5 (F, d)	,,	21	,,	,,	394 George-street (Waters).
H.W.	,,	4 (G)	,,	22	,,	,,	390 George-street.
H.M.	,,	3 (I)	,,	23	,,	,,	80 King-street.
L.D.	,,	13 (K)	,,	25	,,	,,	390 George-street.
E.F.	,,	14 (L, d)	,,	26	,,	,,	96 King-street (Flegeltaub).
G.E.	,,	11 (M)	,,	27	,,	,,	390 George-street.
L.C.	,,	12 (N)	,,	27	,,	,,	390 George-street.

26. On 10th January the Local Authority for the City of Sydney submitted the carcases of 3 rats which had been found in Bank Court, King-street (see diagram), and on 15th January a fourth, in all of which plague was identified in the laboratories of this Department. Two premises which communicated at back with Bank Court by doors in their basements were at that date in occupation of Sargent as restaurants—namely 390 George-street and 80 King-street; but the latter premises were in course of being relinquished by them, and the internal fittings were being removed. H.M. (Case 3), and W.D.S. (Case 2), were employed on that work; H.M. reported that he had seen, but had not touched, 2 dead rats there about 8 days before he fell ill, that is to say, about the 15th January, and W.D.S. said that he had on that date collected and destroyed 2 dead rats; both men said also that there were very many fleas. The premises were well found and in very good order; only the large basement room with a tiled floor, which was used as a coffee-room, had a 4-feet ornamental wainscotting of wood which, after having been torn down, afforded ample evidence of past infestation with rats. On 21st January V.M.S. (Case 5) was attacked; she was a milliner's apprentice employed at Waters' premises which, though referred to as 394 George-street, were corner premises which extended along King-street, and over the archway which formed the entrance to Bank Court; they were thus brought into juxtaposition with 80 King-street, and in the room in which V.M.S. worked all day a used rat-hole was found which communicated with the adjoining premises. In the meantime the Local Authority for the City submitted rats which had been taken on neighbouring premises (but not from those next to be mentioned) which were all found to be plague-free; and on 23rd January complaint was made to them of offensive smells at 390 George-street. Sargent then, on 24th January, removed an iron ceiling and wooden casing which surrounded two girders in the basement of these premises (not used by customers), and found a number of putrid carcases—more than 12—none of which were submitted. But from patients who had been

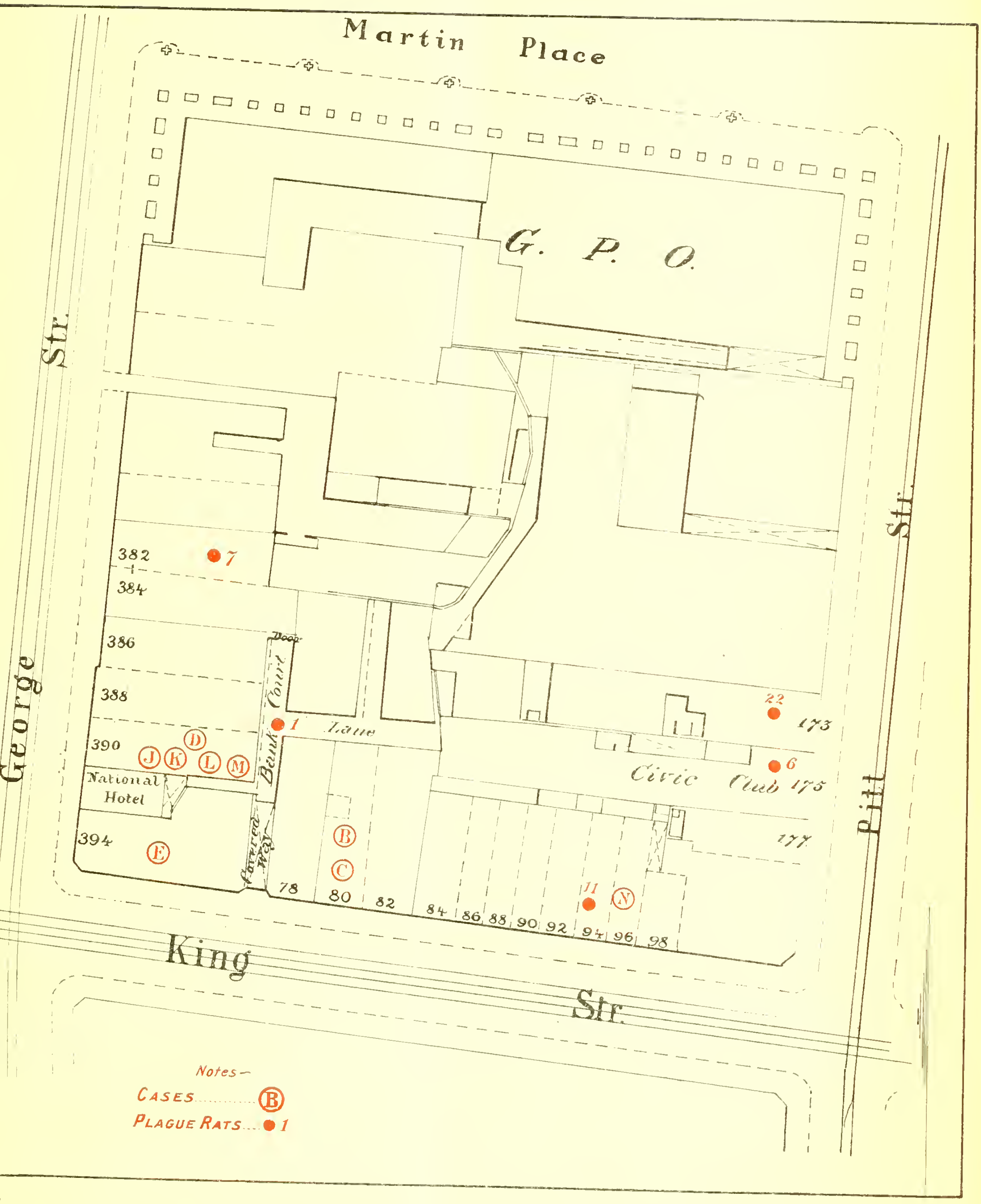

PHOTO-LITHOGRAPHED BY W. A. GULLICK, GOVERNMENT PRINTER, SYDNEY, N.S.W.

been employed on these premises statements were obtained which showed that there had been mortality among the rats infesting other parts of it; thus H.W. (Case 4), attacked 22nd January, said he had lately seen several dead rats lying about, though he had not touched them; while L.D. (Case 13), attacked 25th January, and L.C. (Case 12), attacked 27th January—waitresses—both said that many dead rats had been found recently before. The kitchen was on the top floor, and the waitresses were employed on the second and third floors. The whole of these new, extensive, and fine premises were used as a restaurant and pastrycook's shop, and were excellent in structure and maintenance; with exception of some wooden fittings they presented no faults, but the use to which they were put caused them to become invaded by rats. Possession was taken of the whole block (which included the General Post Office) though without interference with current trade, save at Sargent's—a proceeding afterwards regularised by Proclamation issued by the Executive Government. Evidence of spread of the infection to other parts of the block, in the form of infected rats, was got only in the cases of 382-4 George-street (in communication with Bank Court) and of the Civic Club, 175 Pitt-street, which opened on that court at the back; but another case, E.F., (Case 14) occurred at 96 King-street in the person of a working jeweller there employed, who was attacked 26th January. No plague-rat was found there, nor any good evidence of infestation, but the house abutted on the Civic Club at the back.

THE CAMPBELL-STREET GROUP.

27. The group was composed of the 4 cases, Nos. 6 to 9. They were connected in part clinically, and probably in part merely by locality. Campbell-street lies within the city.

28. Lock, a Chinese, carried on business as a fruit and produce merchant at 24–26 Campbell-street, Belmore Market. Chong Wing On was his foreman and buyer; he lived in Parker-street, close by Campbell-street; his business caused him to frequent the Darling Harbour wharves at which produce is chiefly landed, which were infected with plague at the dates to be mentioned. On 9th January Chong Wing On (Case 6) married a sister of Mrs. Lock, both the latter being natives but the children of Chinese parents. After the wedding he and his wife went to the suburb of Manly for their honeymoon; but he was taken ill on the way on board the ferry-steamer. He returned to Sydney on the 10th, and died at Parker-street on the 13th. Mrs. Chong Wing On (Case 7) nursed her husband; she fell ill during the evening of the 15th January, was removed to a private hospital on the 17th, and died on the 19th. Mrs. Lock (Case 8) was constantly with her sister, Mrs. Chong Wing On, during the latter's illness. She sought advice on 24th January, on the same day was removed to a private hospital, was admitted to the Coast Hospital on the 26th, and died there on the 27th of plague. She had no pulmonary affection, and no bubo (necropsy); efforts to recover the bacillus from peripheral blood taken on the 26th, as well as from heart-blood taken post-mortem, failed. After the cause of her death had been ascertained, inquiry was made of the medical men who had attended her sister and her sister's husband, and who had ascribed their deaths to pneumonia. In view of the ascertained cause of Mrs. Lock's death, they expressed the opinion that probably the disease in both cases had been primary plague-pneumonia.

29. Ma Kong (Case 9) was a labourer who probably worked for Lock, and, with other labourers in that employment, at all events lodged at 24–26 Campbell-street. Straightforward accounts of his relations with Lock could not be got; but there is very little doubt that they were as just mentioned. While in apparent good health, he became suddenly maniacal on Lock's premises on 25th January, and was admitted to the Coast Hospital on the 26th where he suffered from bubonic plague. He was discharged, well, after an illness which had lasted 70 days.

30. Campbell-street is a lengthy thoroughfare; the short part of it in which are Nos. 24–26, together with Belmore Market, which stands opposite to that part, and some neighbouring streets, including Parker-street, is the centre of the distributing produce trade (as distinguished from the other centre constituted by the Darling Harbour wharves at which produce is chiefly landed), much of which is in the hands of such Chinese merchants as remain in Sydney. It is, therefore, exposed to infection from the wharf area; but prolonged search failed to reveal any infected rodent till

9th February, when the infected carcase of a rat was brought in from stables at the rear of 42 Campbell-street (8 doors from No. 26). At a much later date the infection was identified in rats taken in Belmore Market, namely, on 17th May. The two dwellings in Parker-street and 24–26 Campbell-street were free from signs of present infestation with rats, nor were there important signs of any past infestation.

31. The three cases first mentioned above seem to have been directly connected, but it is to be noticed that the third did not suffer from primary plague-pneumonia, the form exhibited (it would appear) by the second case from which (presumably) the infection was passed on. Chong Wing On, although he lived in another house, must have been intimately associated with 24–26 Campbell-street, and must have spent much of his time there in the course of business. As regards the fourth case, the source of infection can only be conjectured. There is hardly any doubt that the patient lived in the same house with the third patient, but it is not very probable that the two were in contact. This may, nevertheless, have been the case; at the same time, his occupation was one which, as past experience has shown, exposes those who are engaged in it to special risk of contracting plague whenever the disease becomes epizoötic on rats.

ROYAL STANDARD HOTEL GROUP.

32. The group was formed of cases which were associated by locality, six of the affected persons having lived at the Royal Standard Hotel, either as lodgers, or as servants, or as members of the proprietor's family, while the seventh was constantly employed there as cook, but lodged at some little distance away. Particulars concerning them are shown in the table below, in which their cases are inserted in the order of dates of attack :—

TABLE V.

—	—	—	—	—	Attacked.	Notified.	Isolated.	Discharged.	Died.	Clinical Form.
19	J.F. ...	M	18	Gen. useful ...	9 Feb...	12 Feb...	17 Feb...	26 Mar...	......	Bubonic.
18	I.R.I...	F	37	Lodger ...	10 „ ...	12 „ ...	12 „ ...	6 „ ...	......	„
22	G.B....	M	55	Servant ...	12 „ ...	13 „ ...	13 „ ...	......	21 Feb...	Septicæmic.
21	V.I. ...	F	8	Lodger ...	13 „ ...	14 „ ...	14 „ ...	6 „ ...	......	Bubonic.
23	E.F. ..	F	24	Barmaid ...	14 „ ...	15 „ ...	15 „ ...	27 Feb...	......	„
25	H.J....	M	36	Barman ...	18 „ ...	16 „ ...	18 „ ...	21 Mar...	......	„ .
26	G.L....	M	47	Cook ...	15 „ ...	19 „ ...	19 „ ...	......	21 Feb...	„

33. Attention was first drawn to these cases on 12th February, when those of J.F. and of I.R.I. were notified; on which date also G.B. was attacked, but not until 11·30 p.m. It will be noticed that J.F. was not removed for 5 days. This resulted from the extremely slight signs of illness he presented (for he had at no time any constitutional symptoms), and to the negative result of direct and cultural examination of the inguinal swelling he presented; consequently the nature of his case remained obscure until an inoculated guinea-pig had died of plague on the 17th February. But it will also be noted that his infection must have been quite independent of that of I.R.I., since the latter fell ill only about 18 hours after the onset in his case. Secondly, the hours of attack in the first three cases having been about 4 p.m. on the 9th, 10 a.m. on the 10th, and 11·30 p.m. on the 12th, it must be inferred, from the incubation period of this disease, that all three were most probably infected from a common source; besides which, it is an observational fact that the disease is not, and it may safely be added cannot be, communicated from such a case as J.F.'s to others, save by inoculation done under experimental conditions. It may be taken that the first five persons were infected before the 12th; and further, that had the most effectual method of protection been used on that date, namely, evacuation of the premises by the rest of the household, attack of H.J. on the 16th might or might not have been avoided. But G.L. would certainly not have suffered had he left the premises on the 12th, and kept away from them.

34. The hotel was an old brick house, which contained 28 rooms; its outside was not imposing, but still had the advantage over its internal state. It had a basement. It stood at the south-west corner of the intersection of Castlereagh and Bathurst streets, within the city, and in the immediate neighbourhood of several places from which plague-rats had been collected recently; and one plague-rat had been brought in from the hotel itself on 30th January. This infected carcase was submitted by the rat staff maintained by the local authority for the city, and was the 27th carcase taken by it on these premises on and after the 15th January, the other 26 having been examined in the Board's laboratories as usual, and found to be free from plague. The Local Authority was informed as soon as the disease had been identified, and the Medical Officer of Health for the Metropolitan District (Dr. W. G. Armstrong), in his titular capacity of City Health Officer, took the premises in hand; for the inspection, rat-proofing, repair, and disinfection of infected and of unsafe premises, within the city of Sydney only, is a part of his duty in the latter of the two capacities just mentioned. Plague was identified in 3 more carcases delivered at the Board's laboratories on the 31st January, and on 1st February the premises were taken in hand by the city staff under Dr. Armstrong's direction. Four carcases, in which plague was afterwards identified, were then turned out, the ground-floor and basement were treated with a 2 per cent. solution of formalin (used in error by the foreman), the basement was painted with petroleum waste, and legal notice was served on the owner to effect certain structural alterations and to effectually stop rat-holes. This work was begun on the 2nd February; on that date, also, the licensee removed accumulations of rubbish and lumber, and on the 8th was fined for having them on his premises. On 12th February (the day on which the first of the seven cases was notified) the whole house was treated with 2 per cent. formalin solution (used again in error); on the 14th reinspection detected some fresh rat-holes, which were filled up; and on 16th February the whole premises were disinfected with a 5 per cent. solution of phenol. No more rats could be found. At a somewhat later date the licensee closed and abandoned the house.

35. As above mentioned, the trapping and examination of rats on these premises began on 15th January. Between that date and 14th February, 52 rats and 10 mice were collected. Among the rats there was but one *M. decumanus* (18th January), the remainder having been *M. rattus.* All the infected rats were of the latter species only; the mice were not infected. The infected rats numbered 17, and they were taken almost day by day between 30th January and 5th February; one other was observed 14th February.

36. This instance may be compared with that furnished by the Criterion Hotel (see Report, Sydney, 1902, pars. 199 to 202); and although not so striking in some of its features as that was, yet the attack of V.I., after having left the house in good health for another situated some 12 miles away in a suburb then and always quite free from suspicion of infectiveness, as well as the residence of G.L. in an uninfected part of the city, where he fell ill, are observations worth notice.

THE ZETLAND GROUP.

37. The group consisted of Cases 38 and 40, father and son, who lived in the same house on the Zetland Estate, Waterloo. This locality lay 3 miles south of the infected centre of the city, and 2 miles south of the nearest point at which a plague-rat had been, or was afterwards, taken.

38. W.G., m., æt. 68, married, bricklayer (Case 38), was suddenly attacked while at work on 22nd March, towards 5 p.m., with vomiting and headache. He went home, and laid there till he died on 28th March. His body was removed to a public dead-house, and on the 29th was examined. Some glands were slightly enlarged, but were apparently normal on section, and there was no bubo; there were punctiform hæmorrhages generally distributed among the internal organs of the body; films, cultures, and inoculations done with material from a swollen gland, and from the spleen and liver, all proved positive. The body was removed from the dead-house to the place of burial direct.

39.

39. W.G.'s movements before attack were traced with considerable exactness During the days from 4th to 16th March, he had worked at a shop which was being reconstructed, and which stood in King-street, a few doors above an hotel where it was thought M.L. (Case 35) received his infection about 14th March. This hotel was badly infested, though plague was not identified in any rat taken in it; but on 4th March a plague-rat had been taken at the shop next to that on which W.G. was at work. He had afterwards worked at, or frequented, some other places in the infected centre of the city and, in short, the origin of his infection in locality was sufficiently probable. He lived on the Zetland Estate in a one-storey brick cottage of six rooms, which was in a good sanitary state; it presented no signs of infestation, although one *M. decumanus* was taken there in the yard, as well as three mice within the house, all of which were free from infection; nor did a prolonged search of the neighbourhood either reveal many rats, or raise any suspicion of plague among them. The cottage was disinfected by the Departmental staff on 29th March. These points have importance in relation to occurrence of the following case in deceased's son, who lived in the same cottage with him.

40. F.D.G., m., æt. 26, single, plumber (Case 40), while in his ordinary good health, was suddenly attacked at 7 p.m., 8th April. On leaving the tea-table, after having eaten as usual, he staggered and had to be assisted to bed; pains in the head and back with feverishness and a sleepless night followed; at mid-day on the 9th he lapsed into unconciousness, from which he recovered after a few hours, and he died on 15th April, after an illness which had lasted seven days. Films prepared from the right inguinal bubo he presented were negative; cultures positive. His body carried many marks of old flea-bites.

41. F.D.G. had been out of work until the day of his attack, when he first had some employment at an iron-foundry which was not infected. He attended his father's funeral on 30th March, and thereafter occupied himself in assisting to trace his father's movements. This caused him to spend his time in the infected centre of the city for the most part, and it may be supposed that he ran more or less into the same danger as his father, since he made minute inquiries at all the latter's places of resort; but his attack cannot thus be satisfactorily accounted for, because his presence in the places referred to was temporary and brief, and because none of all those employed at them suffered after his father. The last occasion on which he could have had contact with his father was ten days before his attack, and, consequently, seven days, or possibly five days before he received the infection. One other person (F.D.G.'s mother) lived in the cottage; she remained well. In this instance, then, as in the cases of the Yule-street, and of the Chippendale groups (see below), it has to be pointed out that in the primary case the disease had the septicæmic form, and proved fatal at the patient's home. These are the circumstances in which fleas may receive the infection from man.

The Chippendale Group.

42. This group consists of the two cases, Nos. 31 and 36, which occurred in one house; but a third, which occurred in another house near by, must be mentioned in connection with it.

43. S.C.D., f., æt. 16, single, confectioner's packer (Case 31) lived with her mother and the forewoman of the room in which she worked at the factory, at 6 Queen-street, Chippendale, a district within the city, but outside the area of known infection. She was suddenly attacked while asleep about 1 a.m. on the morning of 4th March; she was awoke by a rigor, soon became unconscious, and remained so for 12 hours. She died 7th March, after having been ill 72 hours. Her medical attendant having declined to certify to the cause of death, her body was removed on the same day to a public dead-house by order of the Coroner, and in course of the post-mortem examination signs were observed which led to report of the case as one of probable plague. Mesenteric, femoral, inguinal, and other glands were enlarged and exhibited minute hæmorrhages, but there was no bubo; films and cultures made from the liver, the spleen, and the glands mentioned proved positive. Her body was taken direct from the dead-house to the place of burial. The house was disinfected by the Local Authority for the City, under direction of the Medical Officer of Health, on the 8th March.

44.

44. E.L.D., f., æt. 46, widow, household duties (Case 36), was S.C.D.'s mother, and continued to live in the same house, after her daughter's death. She said she had not been away from her street since burying her daughter, except to a neighbouring church five days before her attack. She fell ill suddenly, 16th March, about 3 p.m.; after moving a heavy weight she felt pain in the right groin, and found a lump in it; shortly afterwards she began to shiver, and had feelings of weakness. She was discharged from hospital after an illness which had lasted 26 days. Form, bubonic; films prepared from the right inguinal bubo were negative, but culture and inoculation yielded positive results.

45. The origin of S.C.D.'s infection was not discovered. She was employed with about 120 other hands, mostly girls, at a manufacturing confectioner's in Harris-street, City. The firm had many retail shops, of which two stood well within the area on which most of the cases of this outbreak were infected, but S.C.D. had not visited any of them. Her business was to prepare emptied boxes returned from the various shops (as well as new boxes) by lining them. No other person connected with this factory fell ill; and although there was some evidence of presence of rats it was not infested, was very well kept, well-regulated as regards waste food, and protected by half-a-dozen cats. Traps had been steadily set by the proprietors for many months, but it seemed certain that only two or three rats had been caught or heard of. The patient was well looked after by her mother, returned from work with the forewoman of her room, who lodged in her house, but occasionally went out with friends known to her mother, and visited the infected area—which practically was the central part of the city—after hours. The last occasion on which the mother could have had contact with her daughter was possibly on the fourth, but more probably on the sixth, day before she received the infection which, it appears, must have been taken by her in her house.

46. T.R., m., æt. 37, single, a labourer (Case 34), lived at 9 Milford-street, Chippendale, in a house which was not more than 60 or 70 yards away from 6 Queen-street, though in another street and across a broad road. He was suddenly attacked at 7 a.m. on 16th March; the disease took the bubonic form, and its nature was established by examination of films and cultures made with liquid extracted by puncture from a right inguinal gland. He was discharged from hospital, recovered, after an illness which had lasted 19 days. He had lodged for some months at the house where he fell ill, which was kept by two old people who were the only other occupants. He was out of work and went to many different places in search of it; especially he visited a mason's yard at the foot of Druitt-street on the 13th (or 14th) of March and waited there about half-an-hour. In that locality E.W.E. (Case 39) was infected about the 4th April, and a history of dead rats having been found some days earlier at an office he frequented was got, together with two plague-rats actually collected in the office on the 6th and 10th April; and it was discovered at that time that the whole neighbourhood, consisting of wharves on Darling Harbour, stores, &c., was badly infested with rats which had suffered rather sharply from the epizoötic at a recent date. It may be assumed, therefore, that the foot of Druitt-street was already a dangerous place when T.R. visited it about three weeks earlier, and it seems probable that he got his infection there. The reason for mentioning his case in connection with the other two lies in his landlady, who remained well, having visited S.C.D. during her illness and having assisted in laying her body out after death, in the proximity of the two dwellings, and in attack of T.R. and of E.L.D. on the same day.

47. Failure to identify the source from which S.C.D. had received her infection had already led to investigation of the neighbourhood in which she lived; and when her mother and T.R. were attacked some local source of infection seemed to be indicated rather strongly, so that the search was renewed and pressed. There were some large stables in the locality, and several factories; for the rest, it was occupied by small houses, of which many were in a poor state. Nothing which pointed to plague-infection, however, could be found, and the carcases of such rats and mice as it was possible to collect were free from plague. The nearest point at which a plague-rat was at any time collected was more than three-quarters of a mile away at Campbell-street, 9th February, and at Belmore Market in that street on 17th May, and these were solitary instances.

48. Although it is necessary to mention T.R.'s case in connection with the other two I do not think that it was really related to them. His communication with the D. house was indirect, through intermediary of his landlady, whose last opportunity of acquiring the infection so as to carry it home in a mechanical way occurred four days or six days before the date on which he must have received it; while, on the other hand, he visited many places in the infected neighbourhoods during his search for work, and one of them, which was afterwards discovered to be badly infected, on a day which was either two days or three days before the date of his attack. As a matter of mere probability, choice between the two sources thus indicated is easy; further, as a matter of experience, that which theoretically might have consisted in his landlady is not recognisable as a practical source unless, indeed, she transported an infected flea which did not attack her and which was transferred to T.R.—a merely possible occurrence. The cases of the two D. patients alone, therefore, are clearly associated cases requiring comment; and here, again, it is to be noted that the primary case exemplified the septicæmic form of plague, and ended in death at the patient's home. These are circumstances in which infection of fleas takes place.

THE YULE-STREET GROUP.

49. Yule-street lies in the suburb of Petersham, 3 miles westerly from the nearest point at which a plague-rat was taken during this outbreak, in a neighbourhood which has at no time fallen under suspicion of infectiveness. Three cases occurred in two opposite houses on different sides of the street; the first case was imported, the other two were indigenous.

50. V.M.S., f., æt. 19, draper's assistant (Case 5), was one of the Bank Court group. She fell ill 21st January while at work at 394, George-street, City, at once went home to Yule-street, and died there early on the 26th. Seven or eight hours later her body was removed to a public dead-house, and the nature of her disease was established by cultural and inoculation tests subsequently carried out with material taken from various organs. There was some slight enlargement of a cervical gland or glands on the left side, but there was no bubo, and the clinical form of her illness was the septicæmic. Her body was taken from the dead-house direct to the place of burial. On the day of her death the room she had occupied, and another in which she had occasionally lain during her illness, were disinfected by the Departmental staff. Deceased's father then destroyed some clothing, &c., as a further precaution, and he emptied the rooms, which were not thereafter used by his family, and kept the windows open. The house was a one-storey, detached brick cottage of five rooms, damp, infested with fleas, but clean and in fair general order. Closure of the two rooms referred to obliged deceased's sister, aged 16, to sleep out, and she went to the O.C.'s house on the opposite side of the street, where she shared a bed with one of the two patients mentioned below, the two families being intimate. This girl, and all the other members of the S. family remained well.

51. D.O'C., f., æt. 7, school-child (Case 15), had not been away from home for ten days before attack, save to school, but had visited the S. cottage both during V.M.S.'s illness and after her death. Having gone to bed quite well she awoke with headache on the 6th February about 6 a.m., vomited at 9 a.m., during the evening had pain in the right groin, and at 11 p m. had P. 156, T. 104°. She was removed to hospital on the 7th, and was discharged well on the 29th day from attack. She exhibited fulness and tenderness in Scarpa's triangle, but no definite bubo; cultures made with liquid abstracted from the swelling by puncture on the 3rd and 13th days of illness proved negative, as also did films, cultures, and inoculations done with blood taken from the ear on the 6th day of illness. Nevertheless it was impossible to mistake the disease, and no doubt that it was plague was felt by the experienced staff in attendance on the case.

52. A.O'C., f., æt. 9, school-child, had often visited the S. cottage with her sister. On 6th February, the day of her sister's attack, she was well and went to school as usual. In school she vomited at 3·30, and was sent home; she became feverish immediately, and at 11 p.m. had a temperature of 104°. On the 7th she was but semi-conscious, was removed to hospital, and died there on the 8th, after an illness which had lasted 56 hours. Films, cultures, and inoculation done with blood from the left ear taken on 8th February proved positive; there was no bubo, and the clinical form of the disease was the septicæmic.

53. These two children lived nearly opposite to the S. family in a semi-detached brick cottage in Yule-street, which had one storey and an attic-room; it was a poor property, but in fair general order. In both cottages there were the parents and several other children besides those mentioned; in neither family did any other person fall ill. The O'C. children who were attacked were in and out of the S. cottage during V.M.S.'s illness, and after her death; it could not be ascertained whether they entered the rooms she had occupied, but it was thought by the S. family that most likely they did not. It was not ascertained with which of the O'C. patients V.M.S.'s sister slept. The O'C. cottage was not infested with fleas. The school was quite free from suspicion of infection. As regards rats, there were none at the S. cottage, and at the O'C. cottage one old rat-hole alone furnished evidence of their past presence. Inquiry showed that there were practically no rats in the immediate neighbourhood, which was almost entirely occupied by small cottages, and none could be collected for examination. Nothing which pointed to, or aroused suspicion of, infection was subsequently at any time detected over a wide area which surrounded the centre formed by these two households.

54. V.M.S.'s body was removed from her house, where she had lain ill and died, on the day of her death; the last date on which the two O'C. children could have been in contact with it was midday on 26th January. Her room and effects were disinfected the same day. The children were suddenly attacked 11 days later; they were not infected directly from her, therefore. But during this interval they (*a*) were in contact at night at least with deceased's sister (who remained well beyond doubt), and (*b*) entered her house, and may even have entered her disinfected sick room, though on this point there is no evidence. Deposited infection might possibly have been encountered by them at the S. house at a date within the incubation period of plague, or, consequently, might possibly have been carried thence to them by deceased's sister. But, as has been remarked above, spread of the infection in those ways, if it took place, would constitute an exception to all preceding experience at Sydney, which has shown that the infection has not been so disseminated. The only explanation which carries with it any probability supported by experience arises out of the two following facts:—V.M.S. died of plague in the septicæmic form, and the cottage in which she lived, and which the O'C. children entered after her death more or less frequently, was badly infested with fleas. Unless the infection were preserved in the bodies of some of those insects, it is very difficult to see how the two children could otherwise have been so infected as to fall ill almost simultaneously, or, indeed, have been infected at all.

The Marrickville Outbreak.

55. This outbreak consisted in 2 cases only (Nos. 46 and 47), both of which were separated from Case 45 by an interval of about seven months; they represent the beginning of the subsequent "season," therefore.

56. E.K.W. (Case 46), f., æt. 21, single, was attacked 27th December. She stitched flour-bags at Joyce Bros. & Co., corner of Hay and Lackey Streets, Darling Harbour, and lived at 35, Thomas-street, in the suburb of Marrickville, some 3½ miles away. Her place of employment was newly built, very well kept, and, after inspection, was considered to offer no ground for suspicion of infectiveness. Some rats were caught which were free from infection, but there was no infestation; no plague-rat had been taken in the neighbourhood for many months, and none from the Darling Harbour wharf-line since the 21st October. Her residence, a good brick cottage, semi-detached, in good order, was found to be free from signs of infestation by rats. It stood about 70 feet from Asprey's corner produce store, 156, New Canterbury-road, and on the same side of Thomas-street, where a large business was carried on; besides the shop there were three store-rooms, each of which measured 50 feet x 30 feet. Rumours of dead rats and offensive smells at this store were heard, and on searching it many carcases of rats and mice, and many live rats were taken, but only in the storeroom known as No. 3; in several carcases the infection of plague was identified. It was ascertained that Asprey got his supplies in part from the country, in which case they were carted direct from a

neighbouring suburban station, but in part, also, from Howard Smith & Co.'s wharf at Darling Harbour. No direct connection between E.K.W. and this store was made out; but it was learned that she was in the habit of standing for some minutes on the pavement outside No. 3 store while taking leave of her friends after evening walks. During search of the neighbourhood, plague-infected carcases were also found at 34, West-street, and at 95 and 103, New Canterbury-road, all of them near Asprey's; and ultimately it appeared that spread of the infection had been limited to the small area thus indicated.

57. No other cases occurred in Marrickville, or in the adjoining borough of Petersham in which the last-mentioned infected houses stood, but on 29th December, J.H.K. (Case 47) was attacked in the borough of Hurstville, which lies a still longer distance from the city than Marrickville. The patient was a young man who kept five cows, and supplied their milk to his own customers. The neighbourhood in which he traded was, and continued to be, free from suspicion of infectiveness, and no rats could be found either at his cottage or at other premises near it. He was fully occupied with his business, and had seldom visited the city; he had not been to Darling Harbour. But he had obtained supplies of fodder, which included one bag of chaff, from Asprey's on 24th December, and it was ascertained that these supplies were taken from Asprey's No. 3 storeroom.

58. These data, viewed as a whole, render it unnecessary to dwell on the fact that considerable quantities of jute-bags, imported from Calcutta, were habitually stored at Joyce Bros. where E.K.W. worked. Asprey's produce is known to have been infected; the source of its infection, however, is a matter of conjecture. That part which came from the country lay under no suspicion—it was not infected. The wharf from which the remainder was carted had furnished no plague-rat for a very long time; and from no part of the Darling Harbour wharf-line (of which it formed a part), nor from anywhere else, had a plague-rat been got later than 21st October. But it cannot be concluded therefrom that the wharf was actually free from infection. The difficulty there is in accurately following the progress of the epizoötic has often been mentioned in the course of this series of reports; and discovery of a plague-rat on that wharf-line on the 13th January following, as well as at other places near by in close succession, suggests that the two-months' interval was, in its latter part at least, only one of apparent freedom. In fact, the evidence of freedom is but negative; it consisted in failure of the Intelligence Staff to secure plague-rats. This seems to me a probable explanation; but it is possible that the fodder taken by Asprey from the wharf referred to may have been imported in an infected state (Brisbane), or may have lain near such imported and infected fodder in the storage-sheds at the wharf. Unfortunately, this line of inquiry was not followed up.

59. At K.'s dairy, fodder which lay about his sheds was thickly infested by fleas, which attacked the cleansing staff very freely. None of the latter suffered; and I take this opportunity of remarking that such observations made in connection with plague cases have always been recorded by me merely as matters of fact, which might or might not have stood in important relation to the patient's disease. So also the note that the drainage area of buboes presented traces of flea-bites has been frequently made, but only as a matter of fact; and, indeed, I have pointed out (4th Report, 1904, par. 27) that traces of simple punctures (that is to say, those in which no local reaction has taken place) detected at the rather late date at which patients usually first come under observation, have probably resulted from wounds inflicted after the date on which the clinical history showed that the infection must have been received.

60. In the Report for the year 1906, par. 21, an account was given of experiments on the destruction of rats by Danysz's cocco-bacillus, both in the laboratories and in the field, conducted by Dr. R. J. Millard, Acting Microbiologist to the Board. The preparations named "Azoa" and "Ratin" having afterwards become available, Dr. Millard was directed to make further experiments with them. "Azoa" admittedly contains Danysz's cocco-bacillus, put up in a dry form; "Ratin," although said to contain a bacillus independently isolated, in point of fact contains an organism which cannot be distinguished by us from Danysz's cocco-bacillus.

Further

Further Experiments on the Destruction of Rats by "Azoa" and by "Ratin."

By R. J. Millard, M.B., Ch.M. (Syd.), D.P.H. (Camb.), Assistant Medical Officer of Government, Acting Microbiologist to the Board of Health.

AZOA RAT VIRUS.

This virus is put up in 2 oz. bottles, which contain dry pollard presumably impregnated with a broth culture of the virus.

Pure cultures obtained by plating out this material show that the organism has the following characters:—

Morphology.—A small cocco-bacillus. Actively motile. Gram negative. Tendency to bipolar staining with carbol fuchsin.

Culture.—Grows readily at 37° C. on all the ordinary media.

Agar.—A moist creamy growth. Gelatine not liquefied.

Broth.—General turbidity in 24 hours.

Potato.—A creamy growth, with some blackening of the potato.

Milk.—Slight acidity in first 24 hours, followed by alkalinity.

Indol.—Not produced.

Glucose and Mannite.—Acid and gas produced.

Lactose.—Slight acidity only.

Saccharose.—Neither acid nor gas.

Feeding and inoculation experiments gave the following results:—

I.—Feeding with the virus according to the printed instructions issued with each bottle. The virus was mixed with dry pollard in the prescribed proportion, namely, 1 bottle of virus to 1 lb. of pollard. This mixture was fed to the following animals:—

A.—*White Mice*—

No. 1,479.—11th April, fed; 12th, food eaten; 15th, comatose; 16th, dead.

Post-mortem Examination.—Heart wall dark and injected. Lungs apparently normal. Costal pleura inflamed, fluid in pleural sac increased. Liver enlarged and congested. Spleen enormously enlarged, and very soft. Kidneys and suprarenals congested.

Smears.—From liver, spleen, and heart blood contained numerous Azoa cocco-bacilli.

Cultures.—Liver and heart blood gave pure culture of Azoa. Spleen, a mixed growth of this and another.

No. 1,480.—11th April, fed; 15th, food eaten; 16th, sick; 17th, dead.

Post-mortem Examination.—Heart wall dark and injected. Lungs pneumonic. Costal pleura inflamed, bloodstained fluid in pleural sac. Spleen enlarged and congested. Gut distended with watery contents. Kidneys and suprarenals congested.

Smears.—From liver contained fairly numerous Azoa cocco-bacilli; from spleen and heart blood the same, scanty.

Cultures.—Liver and spleen gave pure culture of Azoa. Heart blood a mixed culture containing Azoa.

No. 1,524.—3rd May, fed; 13th May, dead.

Post-mortem Examination.—Liver and spleen very much enlarged and congested. Kidneys and suprarenals intensely inflamed. Intestines filled with watery contents. Hæmorrhagic infarcts in both lungs. Heart dark and injected.

Smears.—From liver, spleen, and heart-blood contained numerous Azoa bacilli.

Cultures.—Yielded pure growths of the same.

No. 1,525.—3rd May, fed; 13th May, very sick; 15th May, dead.

Post-mortem Examination.—Liver enlarged and congested. Necrosed patches on surface. Spleen enlarged. Kidneys and suprarenals inflamed. Intestines filled with watery contents. Lungs slightly congested. Heart dark and injected.

Liver, spleen, and heart blood yielded pure cultures of Azoa.

B.—*Rats* (*M. rattus*)—

No. 1,486 } 11th April, fed.
No. 1,487 } 12th April, food upset; fresh supply provided.
No. 1,488 } 18th April, no effect; fresh supply.
No. 1,489 } 3rd May, no effect having been produced, the rats were this day killed by chloroform and examined. The organs were in each case found to be normal in appearance. Insemination of Azoa tubes with liver and spleen substance yielded no growth.

C.—*Other Animals*—

No. 1,483, pigeon; No. 1,484, rabbit; No. 1,485, guinea-pig—

11th April, fed.

12th April, food upset; fresh supply, this time of corn damped with water and mixed with Azoa.

18th April, fresh feeding of the same.

3rd May, no effect having been produced, these animals were killed by chloroform and examined. The organs were in each case found normal, and cultures made from spleen, liver, and heart-blood yielded no growth.

No. 1,514, redhead; No. 1,515, black nun—

22nd April, fed with seed mixed with Azoa virus. No ill effect produced up to 20th May.

I*b*. Feeding with Azoa culture after growth for 24 hours on the broth recommended by Dr. Danysz for the preparation of his rat virus (*i.e.*, bouillon plus the bouilli). Mixed with corn and pollard.

A.—*White Mice*—

No. 1,532.—9th May, fed; 15th May, dead.

Post-mortem Examination.—Liver and spleen congested. Kidneys and suprarenals inflamed Lungs slightly congested. Heart dark and injected. Intestines normal.

Liver, spleen, and heart blood yielded pure cultures of Azoa.

No. 1,533 }
No. 1,534 } 9th, May fed; 15th, May dead.

Post-mortem and Cultural findings as in case of No. 1,532.

No. 1,535.—9th May, fed; 15th May, sick; 16th May, dead.

Post mortem findings as in case of No. 1,532, with the addition of necrotic areas in the liver. Cultural results the same.

B.—*Rats* (*M. rattus*)—

No. 1,536 }
No. 1,537 } 9th May, fed; 5th June, no visible ill effect; 10th June, escaped and not recaptured.

No. 1,538.—9th May, fed; 21st May, dead.

Post-mortem.—No visible affection of organ.

Spleen and liver yielded pure cultures of Azoa.

No. 1,539.—9th May, fed; 21st May, dead.

Post-mortem.—No visible affection of organs. Trypanosomes in heart blood.

Liver, spleen, and heart blood yielded pure cultures of Azoa.

C.—*Other Animals*—

No. 1,540, rabbit; No. 1,541, guinea-pig—

9th May, fed; no Azoa infection produced.

II. Feeding with infected carcases.

i. Material used.—Carcases of No. 1,479 (white mouse), infected by feeding (*vide supra*), and of No. 1,482 (guinea-pig), infected by inoculation. Both these animals died on 16th April. Two rats were thus fed with the following results:—

Nos. 1,492 and 1,493 (*Rattus*), 16th April, fed; 3rd May, no visible ill effect having appeared, both were killed by chloroform and examined; no naked-eye signs of disease were present. Cultures made from No. 1,493 were negative, but the liver and spleen of No. 1,492 yielded pure cultures of Azoa.

ii. Material used.—Carcase of No. 1,545 (white mouse), dead on 20th May of Azoa infection after inoculation.

Nos. 1,536 and 1,537 (*Rattus*)—20th May, fed; 5th June, no visible effect; 10th June, escaped and not recaptured.

iii. Material used.—Carcase of No. 1,546 (white mouse), dead on 20th May of Azoa infection after inoculation (*vide infra*).

Nos. 1,528 and 1,529 (*Rattus*)—20th May, fed; 14th June, no visible effect; killed with chloroform; post mortem; normal; cultures negative.

iv. Material used.—Carcase of No. 1,547 (*Rattus*), dead on 21st May of Azoa infection, after combined inoculation and feeding (*vide infra*).

No. 1,549 (*Rattus*)—21st May, fed; 20th June, found dead, but not of Azoa infection; cultures from organs were negative as regards Azoa.

No. 1550 (*Rattus*)—21st May, fed; 24th June, no visible effects so far; killed with chloroform and found on examination to be normal; cultures from organs were negative for Azoa.

III. Inoculation with broth emulsion of Azoa virus, made by mixing the virus with a small quantity of sterile broth.

No. 1,476 (guinea-pig)—

8th April, inoculated in right groin with ·5 c.c.

12th to 15th April, out of sorts.

18th April, well again.

3rd May, no further ill effect; killed by chloroform and examined; no signs of disease; cultures from organs negative.

No. 1,477 (*M. rattus*)—

8th April, inoculated in left groin with ·5 c.c.

3rd May, no ill-effect having appeared, was to-day killed by chloroform and examined; no signs of disease; cultures from organs negative.

IV. Inoculation with broth culture of Azoa virus after incubation at 37° C. for 48 hours.

No. 1,481 (rabbit)—

11th April, inoculated in left grain with 1 c.c.

12th to 15th April, sick.

17th April, better.

22nd April, well again.

3rd May, no further ill effect; killed by chloroform and examined; no signs of disease of internal organs; cultures from these negative; in left thigh was a small collection of pus; culture from this pus was a mixed growth; Azoa cocco-bacillus could not be isolated.

No. 1,482 (guinea-pig)—

11th April, inoculated in right groin with 1 c.c

12th April, sick.

16th April, dead.

Post-mortem Examination.—Right inguinal glands much enlarged and inflamed, and surrounded by large amount of bloody effusion. Peritonitis. Liver and spleen greatly enlarged and congested. Kidneys congested, but not suprarenals. Heart dark and injected. Left lung had two large hæmorrhagic infarcts in the lower lobe.

Smears.—From right inguinal glands, spleen, liver, and heart-blood contained scanty Azoa cocco-bacilli.

Cultures.—Right inguinal glands, spleen, and liver yielded pure cultures of Azoa.

No. 1,528 } (*M. rattus*)—
No. 1,529 }

6th May, inoculated in right groin with 1 c.c.
14th June, no visible effect; killed with chloroform.
Post mortem.—Normal. Cultures from organs negative.

V Inoculated with blood of infected animal.

i. With blood of No. 1,532 (white mouse), dead on 16th May of Azoa infection.
No. 1,543 (white mouse) } 16th May, inoculated.
No. 1,544 (white mouse) } 20th May, dead.

Post-mortem.—Liver and spleen enlarged and congested. Kidneys and suprarenals inflamed. Intestines filled with watery contents. Lungs congested. Heart dark and injected.

Liver, spleen, and heart blood yielded pure culture of Azoa.

ii. With blood of No. 1,533 (white mouse), dead on 16th May of Azoa infection.
No. 1,545 (white mouse) } 16th May, inoculated.
No. 1,546 (white mouse) } 20th May, dead.

Post mortem.—Same as in case of Nos. 1,543 and 1,544, except that in No. 1 546 intestinal contents were normal.

Liver, spleen, and heart blood yielded pure culture of Azoa.

SUMMARY OF LABORATORY EXPERIMENTS.

I.—Feeding with virus according to printed instructions.

Lab. No.	Animal.	Result.
1,479	White mouse	Dead in 5 days. Azoa isolated from organs.
1,480	"	" 6 " " "
1,524	"	" 10 " " "
1,525	"	" 12 " " "
1,486 to 1,489	4 *M. rattus*	No infection after 22 days. Cultures negative.
1,483	Pigeon	" " "
1,484	Rabbit	
1,485	Guinea pig	
1,514	Redhead	No effect after 28 days.
1,515	Black nun	" "

Feeding with Azoa culture grown on Dr. Danysz broth.

Lab. No.	Animal.	Result.
1,532	White mouse	Dead in 6 days. Azoa isolated from organs.
1,533	"	" " "
1,534	"	" " "
1,535	"	Dead in 7 days
1,536	*M. rattus*	No visible effect in 30 days; then escaped.
1,537	"	
1,538	"	Dead in 12 days. Azoa isolated from organs.
1,539	"	
1,540	Rabbit	No infection produced.
1,541	Guinea-pig	

II.—Feeding with infected carcases.

Lab. No.	Animal.	Result.
1,492	*M. rattus*	No visible effect after 17 days. Killed with chloroform. Azoa isolated from organs.
1,493	"	
1,536	"	No visible effect after 20 days. Then escaped.
1,537	"	
1,528	"	No visible effect after 25 days. Killed with chloroform. Cultures from organs negative.
1,529	"	
1,549	"	Died in 30 days. No Azoa infection.
1,550	"	Killed after 34 days. No Azoa infection.

III.—Inoculation with broth emulsion of Azoa.

Lab. No.	Animal.	Result.
1,476	Guinea-pig	Killed after 25 days. No infection.
1,477	*M. rattus*	" " "

IV.—Inoculation with broth culture of Azoa.

Lab. No.	Animal.	Result.
1,481	Rabbit	Killed after 22 days. No infection.
1,482	Guinea-pig	Dead in 5 days. Azoa isolated from organs.
1,528	*M. rattus*	Killed after 39 days. No infection.
1,529	"	" " "

V.—Inoculation with blood of infected animal

Lab. No.	Animal.	Result.
1,543	White mouse	Dead in 4 days. Azoa isolated from organs.
1,544	"	" " "
1,545	"	" " "
1,546	"	" " "

EXPERIMENT ON SHIP "HARTFIELD."

A practical trial on a large scale was made on board the ship "Hartfield," 1,815 tons, lying at Gibbs' Wharf, Darling Harbour. The ship had recently arrived in port, with general cargo, and was ascertained to be badly infested with rats. The distribution of baits, and observation as to number taken, were entrusted to one of the experienced rat-catchers employed by the Department (Adams).

For each day's distribution three bottles of Azoa were used, mixed with 3 lb. of oatmeal. To this sufficient water was added to make a thick mash, which was then put up in small paper twists.

The following table shows the number and distribution of the baits each day, and the number found next morning to have been taken :—

	13th May.		14th May.		15th May.		16th May.		Total.	
	Laid.	Taken.	Laid.	Taken.	Laid.	Taken.	Laid.	Taken.	Laid.	Taken.
Sail-room	40	40	30	30	30	30	30	30	130	130
Main hold	147	147	...	...	...	...	...	...	147	147
Lamp-room	...	...	5	5	6	6	6	6	17	17
'Tween decks	...	...	69	69	60	60	60	60	189	189
Lazarette	...	...	20	20	20	20	30	30	70	70
Lower hold	...	...	60	60	60	60	62	62	182	182
Chain-locker	...	...	...	...	20	20	20	20	40	40
Cook's galley	...	...	...	...	...	...	6	6	6	6
Carpenter's room	...	...	...	...	...	...	6	...	6	4
Total	187	187	184	184	196	196	220	218	787	785

The ship was kept under daily observation by the rat-catcher, to ascertain the occurrence of any mortality or sickness among the rats, and to obtain any sick or dead rats for laboratory examination. The reports of the ship's company were that the rats were less noticeable, *e.g.*, made less noise a few days after the distribution of baits had been begun, but no dead or sick rats were then reported.

Two weeks after the first distribution of baits, *i.e.*, on 27th May, when it was reasonable to suppose that the virus had been well disseminated throughout the ship, I caused the rat-catcher to obtain live rats by means of cage-traps, and to bring these to the laboratory to be kept under observation. In all, 98 rats were thus obtained in the five days, 27th May to 31st May. Some of these appeared sickly on receipt at the laboratory, but this was apparently due in part, at least, to starvation, for they were very thin, and soon recovered when placed in a large cage and suitably fed. Of the total 98, 3 died on 3rd, 5th, and 11th June respectively. In none of these 3 could Azoa infection be demonstrated. The remaining 95 continued in good health and condition during a prolonged period of observation extending over some two months.

During the period 27th May to 31st May, however, the rat-catcher found in all 24 dead rats on the ship. Examination of these showed Azoa infection in 14, 5 were putrid, and in 5 others no evidence of infection was obtained.

On 2nd June the ship, having discharged her cargo and being about to load coal, was fumigated, while empty, with sulphur, with the object of killing the remainder of the rats. On searching after fumigation, 58 freshly-dead rats were obtained. These were cut open and examined at the laboratory, and in the case of 28, *i.e.*, all those in which there was the least indication of disease, cultures were made from liver and spleen. The results of these cultures were as follows :—

Azoa pure culture...	3
Overgrown	8
Not Azoa	6
No growth...	11
Total	28

The facts concerning this ship experiment may be summarised as follows :—

1. In the four days, 13th May to 16th May, 785 baits made from 12 bottles of Azoa were taken by the rats on the "Hartfield."
2. In the period 27th May–31st May, 24 dead rats were found on the ship, and of these, 14 were definitely infected with Azoa, 5 were putrid, and for this reason could not be diagnosed as infected or not, and 5 were not infected.
3. In the same period, 27th May–31st May, 98 live rats were obtained, which showed no evidence of infection, though kept under observation for many weeks subsequently.
4. On 2nd June there were still at least 58 live rats on board, as ascertained by fumigation, and of these 3 were definitely Azoa infected, 8 others may have been so infected, while the remaining 47 showed no sign of infection.

From these observations it would appear that although some infection of the rats was produced, no considerable epizoötic was caused thereby, and that the fatality amongst such rats as were infected was small.

On 5th and 6th September Azoa baits, to the number of 1,400, were distributed by the Departmental rat-catching staff in the several areas along the harbour front in which they set their traps. The places where baits had been laid were kept under careful observation, and it was noted that by 23rd September every one of the baits had been taken.

Up to the present date no Azoa-infected rodents have been obtained, though during the period 6th September–24th October this same rat-catching staff has obtained from these same areas 1,219 rodents, which have all been examined at the laboratory.

There has, it is true, been a slight falling off in the number of rats brought in by the staff, as shown by the figures below; but the figures for the corresponding periods of last year show that then, also, there was a similar decrease in September and October, as compared with July and August, and it is probable that the decrease this year was due to other causes than the distribution of Azoa on 5th and 6th September.

RODENTS BROUGHT IN BY RAT-CATCHING STAFF.

	1906.	1907.
4 weeks ending 1st August	1,006	796
Do 29th „	1,039	735
Do 26th September	878	708
Do 24th October	852	694

RATIN.

This virus is supplied in tins holding about 3 lb. The material is apparently boiled and mashed potato impregnated with a broth culture.

Pure cultures obtained by plating out show that the "Ratin" virus is a cocco-bacillus. Its morphological and cultural characters appear to be identical with those of the "Azoa" virus, already described.

Feeding and inoculation experiments have been performed with the following results:—

I. Feeding with virus as supplied.

N.B.—The material was readily eaten by all the animals.

No. 1,494. *White Mouse*—

17th April, fed.

19th April, dead and partially eaten by No. 1,495 (white mouse which was in the same cage).

Post-mortem Examination.—Liver and spleen enlarged and congested. Kidneys and suprarenals inflamed. Costal pleura inflamed. Heart and lungs had been eaten by No. 1,495.

Smears from liver and spleen contained scanty Ratin cocco-bacilli.

Cultures.—Liver and spleen. No Ratin isolated.

No. 1,495. *White Mouse*—

17th April, fed.

18th April, fresh supply of Ratin.

19th April, had eaten heart and lungs of No. 1,494.

3rd May, dead.

Post-mortem Examination.—Liver and spleen enlarged. Kidneys and suprarenals inflamed. Heart, dark and injected. Lungs normal. Bowels normal.

Smears.—Liver and spleen. Ratin cocco-bacillus. Heart-blood negative.

Cultures.—Liver, spleen, and heart blood. Pure culture Ratin bacillus.

Nos. 1,498 to 1,506 inclusive. 9 *M. decumanus*—

17th April, fed.

18th April, fresh supply.

22nd May, remain well. Killed to-day with chloroform, and examined. No indication of infection. Cultures negative.

II. Feeding with infected carcase.

No. 1,508. *M. rattus*—

19th April, fed with carcase of No. 1,494 (white mouse dead after feeding with Ratin virus).

22nd May, remains well. Killed to-day with chloroform. No indication of infection. Cultures negative.

III. Inoculation with broth emulsion of virus.

Nos. 1,496 and 1,497. 2 *M. decumanus.*

No. 1,507. Guinea-pig.

17th April, inoculated with 1 c.c. Rats in left groin, guinea-pig in right groin.

22nd May, remain well. Killed to-day with chloroform, and examined. No indication of infection. Cultures negative.

IV. Inoculation with broth culture of virus after incubation at 37° C. for 48 hours.

No. 1,509. Guinea-pig—

19th April, inoculated with 1 c.c. in left groin.

26th April, sick with bubo.

27th April, dead.

Post-mortem Examination.—Left inguinal glands very much enlarged and necrosed. Much infiltration of surrounding tissue. Right inguinal glands also enlarged and deeply congested. Cutaneous vessels in neighbourhood engorged. Peritonitis. Liver much enlarged and injected. Spleen enlarged, dark, and showing many small areas of necrosis (miliary speckling). Kidneys injected. Vessels of stomach wall and small intestine markedly engorged. Cæcum distended with watery contents. Both lungs engorged. Heart dark and injected.

Smears.—From L. inguinal glands, contained numerous; from liver, spleen, and heart blood, scanty Ratin cocco-bacilli.

Cultures.—L. inguinal glands, spleen and liver, yielded abundant pure cultures of Ratin. Heart blood culture, 1 colony of Ratin.

EXPERIMENT

EXPERIMENT ON BARQUE "QUILPUE."

As in the case of Azoa Rat Virus, a practical trial on a large scale was made on board a vessel. The vessel chosen was the barque "Quilpue," 1,316 tons, recently arrived with general cargo, which she was discharging at Federal Wharf, No. 1. She subsequently proceeded to Newcastle to load coal. She was reported as rat-infested, and this report was confirmed by the readiness with which the Ratin baits were taken.

Before any Ratin was distributed on the barque, 21 rats were caught on board and examined, and were all found free from disease.

Baits were made according to the manufacturer's instructions, by putting up the Ratin in small paper twists, and from 9–14th May inclusive, were distributed on board as shown in the table below, daily observations being made as to the number taken.

	9th May.		10th May.		11th May.		13th May.		14th May.		Total.	
	Laid.	Taken.	Laid.	Taken.	Laid.	Taken.	Laid.	Taken.	Laid.	Taken.	Laid.	Taken.
Chain-locker	10	10	10	10	10	10	10	10	10	10	50	50
Sail-room	20	20	20	20	20	15	20	20	20	20	100	95
Port W. C.	3	3	3	3	3	3	3	3	3	2	15	14
Starboard W. C. ...	3	3	3	3	3	3	3	2	3	3	15	14
Paint locker	4	4	4	4	4	4	4	4	4	4	20	20
Water tank in hold ...	...	...	20	20	20	12	20	20	20	20	80	72
Main hold	144	136	128	108	124	100	120	84	115	95	631	523
Cabin	3	3	3	3	3	1	3	2	3	0	15	9
Carpenter's room ...	...	...	6	6	6	6	6	6	6	0	24	18
Total ...	187	179	197	177	193	154	189	151	184	154	950	815

The "Quilpue" was kept under daily observation by the rat-catcher who had laid the baits, but no evidence of disease among the rats was obtained. Rats from the vessel were examined bacteriologically, as follows:—

May 10th	2
" 16th	1
" 20th	3 killed by dog.
" 22nd	14 trapped.

In none of these could Ratin infection be found. On 29th May the "Quilpue" went to Newcastle, and was there fumigated with sulphur while she was empty, prior to loading with coal. The object of this fumigation was to kill such rats as were still on board. As the result of a search on 31st May, 25 freshly dead rats were found, and these were brought to the laboratory in Sydney, where bacteriological examination showed no signs of Ratin infection. Some days later 11 more dead rats were found, which were putrid, and thus unsuitable for bacteriological examination. These also had probably been killed by the sulphur fumigation.

The results of this experiment may be summed up as follows:—

1. On a rat-infested vessel 950 Ratin baits were laid, and 815 taken in the six days, 9–14th May.
2. No evidence was obtainable of the establishment of an epizoötic among the rats by this distribution of Ratin.
3. Of the 39 rats caught or killed on board on 22nd May and 31st May none showed Ratin infection.
4. As the result of fumigation on 31st May, *i.e.*, three weeks after first baits were laid and taken, 36 rats were killed, and these probably represented the entire rat population of the vessel at that date.

FIELD EXPERIMENT AT GLADESVILLE.

The Hospital for Insane, Gladesville, where a field experiment with the Danysz rat virus had been conducted by me under instructions of the Chief Medical Officer of the Government (Dr. J. Ashburton Thompson) in November, 1906 (see Report, 1906, par. 21), was by permission of the Inspector-General of the Insane utilised for a field experiment with Ratin.

The same locality as before, namely, the roadway below the piggery and the cesspits where the hospital nightsoil is deposited, was selected for the experiment, as inspection showed that rats were numerous in these places.

The baits were prepared according to manufacturer's directions, and were distributed on 31st May. In all 620 baits were laid.

Reports obtained subsequently from time to time from the Assistant Superintendent of the Hospital were uniformly negative as to dead or sick rats having been observed by the staff. Nevertheless there was apparently a considerable diminution in the rat population, and when a final survey of the place was carefully made on 2nd August, *i.e.*, two months after the distribution of baits by the rat-catcher (Allen) and myself, we found a few rats, and found, moreover, that many of the rat runs which had formerly been most in use were now overgrown with weeds or cobwebs.

Ratin No. 2.

On 13th August there was received at the laboratory a consignment of 50 tins of "Ratin No. 2," presented by the Ratin Bacteriological Laboratory through the Agent-General for New South Wales, and despatched from London on 21st June, per R.M.S. "Moldavia."

The Agent-General in his letter on 17th May (No. 07–7022), stated that this Ratin was said to possess better keeping qualities."

The tins, which bore the date of 27th May, were found to contain bread, soaked with a brownish fluid, presumably a broth culture. Of the 50 tins 11 were "blown," and in all 50 the reaction of the contents was found to be strongly acid. Attempts to grow the Ratin cocco-bacillus failed in the case of all but 7 tins, the following being the results obtained :—

36 tins yielded no growth in broth or on Agar. Of these 4 were "blown."
7 tins yielded a growth, but not of Ratin. Of these 3 were "blown."
7 tins yielded a growth of Ratin. Of these 4 were "blown."
—
50

Experiments with this Ratin No. 2 were made on rats as follows :—

Feeding with Ratin mixed with Milk as directed.

Twelve rats (*M. rattus*) were given this food, but they showed an obstinate aversion to take it, and left it almost untouched while they gradually starved.

1 was dead on the 3rd day.
5 were dead on the 6th „
3 „ „ 7th „
3 were given other food on the 7th day, and forthwith recovered.

The post-mortem examinations of those rats that died gave almost uniform results. In all there was great emaciation, and from none was there obtained in either smear or culture of the organs a micro-organism at all resembling the Ratin cocco-bacillus. From these circumstances it was concluded that the rats had died of starvation.

Subcutaneous Injection.

Three rats (*M. rattus*) received a subcutaneous injection in the right groin of 1·5 c.c. broth emulsion of Ratin No. 2. No effect was produced, the rats remaining in good health and condition.

As it was evident that this consignment of Ratin No. 2 had in some way become spoiled, further experiments with it were not made.

61. In considering the causes of the *persistence* of plague at this port, I remarked long ago (Report 1904, par. 13) that there was at least no need to look to a chronic form of the disease in rats, because the sole evidence of persistence consisted in discovery of carcases of rats which had died of acute plague, and because among the large numbers of rats which have been annually examined nothing happens to have been detected which was suggestive of chronic plague. On these grounds I ascribed persistence to the intricate harbourage afforded by ill-constructed wharves on the easterly shore of Darling Harbour, and by dilapidated buildings adjacent to them; but originally, also, I had forcibly pointed out the danger which wharves in the state described entailed in connection with plague (see Report, 13th November, 1900, p. 45). It was to be expected, therefore, that attention would be instantly and earnestly turned to reformation of them; and in point of fact, the Darling Harbour Resumption Act, and the Harbour Trust for the management of the port in general which was created by it, were the direct outcome of the epidemic of 1900, and of recognition of its proximate causes as expounded in the Report just cited. But though the convictions of the Government of the day were attested by this legislation, it turned out that repeated experiences and repeated demonstrations of the same kind were needed to give them practical effect.

62. The Harbour Trust Commissioners commenced on 4th March, 1901. In their first Report (June, 1902) they announced that a beginning had been made of the business of replacing with concrete the natural or roughly-paved surfaces which, covered with wooden flooring or not, formed the ground floors or basements of most of the stores and bonds; and it may be said at once that this work proceeded regularly, and so that, although it was still in progress during the earlier half of the current year (as, for instance, at the extensive Federal stores), it may now, probably, be regarded as completed. But it was not until June, 1904, that the Commissioners were able to report that rat-proofing of the quay-faces had actually begun, and that 150 feet had been completed by application to the sheet-piling of slabs of reinforced concrete. Two years later the Commissioners gave (June, 1906) a summary account of the improvements effected in the port as a whole since the inception of the Trust, and, among many other things, mentioned rat-proofing of quay-faces to a total length of 4,000 feet. Two years later still (June, 1908) the account stood as follows: Approximate length of the water-front from the northerly face of Miller's Point to

the head of the easterly shore of Darling Harbour (see diagram), 10,450 lineal feet; length of face rat-proofed, 7,100 feet; remaining unprotected, 3,350 feet—but these 3,350 unprotected feet include 600 feet belonging to the water-front of the Australian Gaslight Company's property, which the Commissioners cannot touch, so that the unprotected length for which they are responsible was 2,750 feet. Of this, 1,380 feet are reported at the present time of writing (September, 1908) to be in course of being made rat-proof. Thus there is every hope that protection of this, the only dangerous part of the port, may be completed in the course of another year or two, and then, if the surfaces of the quays are also carefully constructed and tended, so that rats can neither break through them nor get under them from behind the rat-proof facing, it may be reasonably expected that control of epizoötic plague will become easier and more complete than it has been in the past. But by themselves these measures are insufficient; they are indispensable, but in order to prevent recurrences of plague complementary precautions of a different kind must also be taken, for nowhere does plague spontaneously originate, or spring up of itself, as an outcome of local conditions.

63. Elsewhere I have ascribed *recurrences* of plague at Sydney to re-importation of infected rats, either from foreign or from Australian infected ports.* This opinion was based in part on the length of the intervals which elapsed between the four earlier epizoötics (15, 8½, and 6½ months), and in part on failure to obtain evidence of plague in the rat during them, notwithstanding steady continuance during the latter two intervals of the methods of search, which, it seemed, always proved efficient when epizoötic plague was indeed present; and that these intervals were real, and not due to some unexplained failure of method, has been shown by the experience of later years, during which epizoötic plague has been ascertained by the same methods to have been almost continuously present at Sydney, though for most part of any year only to a small extent. But if at the close of each of the earlier outbreaks the epizoötic infection had been cleared away, as I believe was the case, then recurrence must have been due to re-importations; and it should be noted in passing that sometimes such re-importations must also have occurred during times of observed persistence when, although not distinguishable, they may well have acted in frustration of our efforts to rid Darling Harbour of the infection. Now, while importation of the infection has been observed in many different parts of the world, consequent communication of it to a clean port has never, I think, been clearly traced to any particular vessel. The reason is that either plague rats have been found and destroyed before the ship has received pratique, so that communication has been made impossible, or else they have not been found, and the fact that the infection has been communicated has become manifest only so long afterwards (in the natural and necessary course, as we now know) that the ship has already cleared outwards, and all chance of tracing it to its source has been lost. These are among the circumstances which, in earlier years, permitted dispute concerning efficiency of the rat as a diffuser of this infection over seas, as well as concerning the dangers run by clean ports which admitted vessels arriving from infected ports without any particular precautions; the argument of the party which maintained the practical unimportance of ships carrying plague-rats, or the infrequency with which ships carried such rats, having been supported by reference to records which, as we have just seen, hardly could (and certainly did not) yield clear evidence to the contrary. As testifying to the practical danger of repeated importations by ships coming foreign two instances have been exactly described in the course of this series of reports (Report, 1902, pars. 50–64, from Capetown, and Report, 1903, par. 24, from Rosario; see also Appendix G, pars. 20–1, p. 63), but both were detected in time and, consequently, the danger was not realised.

64. Secondly, as regards repeated importations from Australian ports, this is probably a much greater danger, and I have no doubt that it has taken effect more frequently. Still, the conditions of coastal trade are such that no definite instance of re-importation by that means can, even now, be described. Many of the steamers which circulate in a constant stream between southern ports and the north are not empty at Sydney except when they are laid up for overhaul; and my experience is that both searches and fumigations of laden, or of partly laden, ships prove inadequate. Evidently searches must be incomplete under those conditions; and formation of air-cushions among coals and cargo on board affords protection to rats which take refuge in them, and is a phenomenon now too well known to

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* Trans. American Medical Association, Boston, June, 1906: Address on the Epidemiology of Plague (see also J. of Hyg., VI., pp. 556–7).

need more than reference in this place. It was under these circumstances that the infection originally (1900) spread to Brisbane, Queensland, more recently to coastal ports within this State (Report, 1905; see also p. 26 below), probably to Fremantle, Western Australia, and either direct, or by way of Brisbane acting as a secondary distributing centre, to several Queensland ports, where at one time or another outbreaks have occurred during the past seven years; and from those ports, which the infection had reached by sea, it must more or less often have been returned by sea both to Sydney and to other places. The case of the coasting steamship "Innamincka" on her voyage of May, 1908, exemplifies the share which may be taken by such vessels in spreading and perpetuating plague so forcibly that, although in that instance also the danger was averted, it is given in some detail below.

65. The Adelaide Steamship Co.'s "Innamincka" runs from Melbourne, Victoria, in the south, to Cairns, Queensland, in the north, carrying general cargo and passengers; going south, her cargo consists chiefly of sugar and bananas. She calls at Sydney, New South Wales, and at Brisbane, Mackay, Townsville, Bowen, and Cairns, Queensland. She is empty only at Melbourne and at Cairns, and at these ports is fumigated for destruction of rats. On the voyage now spoken of the "Innamincka" reached Sydney 21st May, from Cairns, where she had been fumigated as usual, and sailed again for Melbourne on the 22nd. During the night of the 21st a rat-catcher of the Intelligence Staff set many traps on board, and found next morning that 18 live rats had been caught; in addition, he found one dead rat lying beside one of the cages. The live rats were kept for some time, and continued healthy, but the dead rat was found to be infected with plague. The vessel having sailed in the meantime, Melbourne was warned by telegraph. On arrival there on the afternoon of the 24th the vessel was arrested, anchored in the stream, and fumigated with her cargo aboard; the next morning hatches were opened, she was taken alongside, and discharge of cargo was begun. In the course of discharging 160 carcases were found. Having been emptied, she was placed under sulphur a second time during the afternoon of the 25th; and when hatches were again opened on the 26th, 164 more carcases were turned out. After examination a number of these carcases were declared to be plague-infected. The ship was then thought to be rid of rats. She took on 8–900 tons of cargo, and sailed for Sydney as usual on her return voyage to the north. On arrival at Sydney, 29th May, she was searched by the Intelligence Staff, under supervision of the Chief Sanitary Inspector, and 41 live rats and 22 carcases were collected. Consequently, the whole of the cargo then aboard was ordered out, and during the unloading 35 rats were killed, and 34 more carcases were found. The ship was then placed under sulphur for twelve hours, with the result of finding 509 carcases of rats, 12 of mice, and 2 rats alive, though dying. Nevertheless live rats were still heard; the reason was afterwards found to be existence of a hole of communication between a forward hold and a cross-bunker in which some rats had found protection from the fumes among the coals. It was thought necessary, therefore, to empty all the bunkers; this took 36 hours of continuous work. Then the after parts of the vessel with the engine-rooms and stokeholds were first filled with sulphur fumes, after which a second fumigation of the forward holds commenced. After this 70 carcases were found, but no live rats, and it was at length possible to say that no rats alive or dead remained on board; on 3rd June she was released, and, after loading, pursued her voyage. Altogether 734 rats were delivered at the Board's laboratories on or after 29th May, of which about 160 were putrid; 70 of them were examined bacteriologically, being selected from the batches successively brought in, and including some of the putrid carcases; 44 of these yielded positive films, and from 4 of them positive cultures were raised; 3 inoculations were done, and all 3 guinea-pigs presented after death the appearances which are typical of inoculated plague, while from their organs pure cultures of *B. pestis* were recovered. Probably the number of plague-infected animals much exceeded that mentioned, but as soon as practical needs had been met further examination became superfluous. The species of rats was *M. rattus*, and it was observed that a large proportion of the animals were young or half-grown.

66. It was learned that the master of the "Innamincka" had been supplied with a virus for killing rats by a dealer at Brisbane. He said he received 9 tubes, and that he prepared and distributed the contents of 5 of them on 20th May. The other four were handed over by him at Melbourne, and the 2 mentioned below were kindly transmitted to this Department by direction of the Chairman of the Board of Public Health (Dr. W. Perrin Norris). It was necessary, therefore, to ascertain the nature of this virus.

Examination of a virus for destroying rats, prepared by the Pasteur Vaccine Co., Paris. By C. S. Willis, M.B., Ch.M. (Sydney), D.P.H. (Eng.), Acting Assistant Microbiologist to the Board of Health.

On 4th June two tubes of a virus prepared by the Pasteur Vaccine Company of Paris were received from the Department of Public Health, Victoria; they were a part of the supply obtained by the master of the s.s. "Innamincka" at Brisbane on the 18th or 19th of May. One of these tubes had been opened; the other had not been opened, and was still sealed with paraffine as originally sent out. Each tube contained a copious grey growth on Agar, and both gave off a putrid odour on being opened.

The original sealed tube.—The growth in this tube consisted of two varieties: (a) an actively motile bacillus; and (b) a non-motile bacillus. The morphological and cultural characters of these bacilli were as follows:—

(a)

(*a*) *The actively motile bacillus.*

Morphology.—A small oval, actively motile, Gram negative bacillus.

Cultural characters :—

On Agar	An iridiscent growth covering whole slope in a few hours.
In 1 per cent. Glucose broth...	Acid and gas formed.
„ „ Mannite „ ...	No acid or gas.
„ „ Saccharose „ ...	Acid and gas formed.
„ „ Lactose „ ...	No acid or gas.
„ Litmus milk	Slight acidity after 7 days, no coagulation.
„ N.R. broth	Acid, no fluorescence.
„ Broth	Turbid.
„ 1 per cent. Dulcite broth ...	No acid or gas formed.
On gelatine	Liquefaction after some days (3 or 4).
Indol	Quantity of indol and nitrites.

This bacillus belongs to the Proteus group.

(*b*) *The non-motile bacillus.*

Morphology: A bipolar staining bacillus (somewhat like B. pestis), non-motile, Gram doubtful, involution forms present.

Cultural characters :—

On Agar	Small watery discrete growth very like Conn's B. acidi lactici. No density in the growth even after several days incubation.	
In 1 per cent. Glucose broth...	Acid formed.	
„ „ Mannite „ ...	„ „	
„ „ Saccharose „ ...	„ „	
„ „ Lactose „ ...	No acid „	
„ „ Dulcite ...	„ „	
„ Litmus milk	„ „	Milk not coagulated.
„ N.R. broth...	No fluorescence.	
On potato	No growth.	
„ gelatine	No liquefaction.	
In broth	Small flocculi.	
Indol	No indol formed.	

The opened tube.—This was found to contain two bacilli presenting similar morphological and cultural characters to those found in sealed tube.

Inoculation of Animals :—

I. *Guinea-pigs :*

5th June.—Guinea pig (1,955) inoculated in right groin with growth from sealed tube.
15th June.—Dead.

Post mortem.—Intestines inflamed. Liver, spleen, and kidneys normal. Congested patch in left lung. Lymphatic glands not enlarged.

Smears from heart's blood—
Liver ... ... }
Spleen ... ... } Nil.
Right inguinal glands ... }

Cultures from heart's blood—No growth.
„ „ liver—No growth.
„ „ spleen—Staphylococcus albus.
„ right inguinal gland B. pyocyaneus and a diplococcus Gram positive.

5th June.—Guinea-pig (1,956) inoculated in right groin with growth from opened tube.
9th June.—Found dead in yard (had escaped from cage).

Post mortem—All organs normal.
Smears from organs—Nil.
Cultures from organs—No growth.

13th June.—Guinea-pig (1,964) inoculated in right groin with broth emulsion of a culture of the actively motile (Proteus) bacilli.
2nd July.—No symptoms since inoculation. Discharged.
13th June.—Guinea-pig (1,965) inoculated in right groin with broth emulsion of a culture of the non-motile bacilli.
14th June.—24th June, 1908. Well.
25th June.—Sick.
26th June.—Dead.

Post mortem—Spleen ... ... }
Liver ... ... }
Kidneys ... ... }
Lungs ... ... } Normal.
Heart ... ... }
Lymphatic glands... }
Intestines showed signs of muco enteritis.

Cultures from heart's blood }
liver ... } No growth.
spleen ... }

8th July.—Two guinea-pigs (1,981, 1,982) injected in right groin with 1 c.c. broth emulsion of non-motile bacillus.

18th July.—No symptoms since inoculation. Discharged.

Note.—Guinea-pig (1,955, 1,956, and 1,965) apparently died, not as a result of injection, but from some other cause.

II. *Rats:*

5th June.—Two rats (*rattus*) (1,957, 1,958), each injected in right groin with 0 5 c.c. broth emulsion of virus.

26th June.—No symptoms in either since inoculation. Both killed with chloroform.

Post mortem—Appearances normal in both.

Cultures from spleen and liver of both gave no growth.

13th June.—Two rats (*rattus*), (1,966 and 1,967), each injected in groin with broth emulsion of culture of non-motile bacilli.

2nd July.—No symptoms since inoculation. Discharged.

Feeding rats with virus—

11th June.—Rat (*rattus*) (1,962), fed with crushed corn (about ¼ lb.) infected with contents of sealed tube.

2nd July.—No symptoms to date. Discharged.

11th June.—Rat (*rattus*) (1,963), fed with crushed corn (about ¼ lb.) infected with contents of opened tube.

2nd July—No symptoms to date. Discharged.

One sealed tube of rat virus (Pasteur Vaccine Co., Limited) was kindly obtained from the vendor in Brisbane who had supplied the master of the "Innamincka," by direction of the Commissioner of Public Health (Dr. B. Burnet Ham) and forwarded to this laboratory; it was received 6th June. This tube contained a copious grey growth on Agar similar in appearance to the growth in the tubes received from Melbourne. It was found to contain two varieties of bacilli:—

(*a*) An actively motile bacillus forming great part of growth. The morphological and cultural characters of this bacillus were the same as the actively motile bacillius obtained from the Melbourne tubes.

(*b*) A bacillus which I was unable to isolate.

Pathogenicity.—

11th June.—Rat (*rattus*) (1,961), fed with crushed corn (about ¼ lb.) infected with contents of tube.

2nd July.—No symptoms since inoculation. Discharged.

9th July.—White mouse (1,983), injected in left groin with 0·25 c.c. broth emulsion of the contents of tube.

18th July.—No symptoms since injection. Discharged.

The bacilli both in the Melbourne and Brisbane tubes were, therefore, non-pathogenic to rats and guinea-pigs.

In all the tubes the predominating growth was due to an actively motile bacillus belonging to the proteus group. This bacillus was the cause of the putrid odour given off by the tubes when opened.

The second (non-motile) bacillus in the Melbourne tubes I was unable to name, but it was neither B. pestis nor the Danysz cocco-bacillus.

67. It is reasonable to infer from this case, in which presence of the infection was discovered almost by accident, that coastal steamers have probably been an important means of maintaining plague in the Commonwealth from year to year. Special treatment of them is needed in the general interest; and for practical purposes this would best consist in careful fumigation with sulphurous-sulphuric gases, while empty, at regular intervals. The intervals, I think, should be about six weeks, but they might be slightly extended when necessary to suit dates of arrival at terminal ports where alone the vessels could be so handled with but trifling delay. Additionally, any effectual method which may be devised of preventing interchange between ship and shore rats while lying alongside should be enjoined and enforced; but I feel obliged to add that, in my opinion, the measures hitherto taken with that object—namely, fending off, rat-guards on springs and hawsers, closure of openings next the wharf, &c., &c.—have proved of little practical value. The case of the "Innamincka" itself shows that these precautions have not been neglected in the past, and have been taken under direction of the several governments concerned; but it shows, also, that they have not been effectually taken. Nor, I think, is it likely that they will or can be effectually taken as long as they depend on the co-operation of different authorities which are unco-ordinated by any joint agreement formally recognised. However, this obstacle will soon be removed. During the current year the Parliament of the Commonwealth has passed a Quarantine Act, which will be brought into operation by proclamation as soon as the details of the service have been organised, and thus that uniformity of quarantine law and practice in Australia will come about which first began to be urged in New South Wales just twenty-five years since.[*]

J. ASHBURTON THOMPSON.

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[*] Intercolonial Sanitary Conference of Sydney, 1884: President, the Hon. Charles K. Mackellar, M.B., Medical Adviser to the Government; Secretary, J. Ashburton Thompson, M.D., D.P.H. Ordered by the Legislative Assembly to be printed, 26th November, 1884. Sydney: Thomas Richards, Government Printer.

REPORT

REPORT

ON AN

Outbreak of Epizootic and Epidemic Plague at Kempsey, Macleay River, N.S.W., in 1907.

Compiled by R. J. MILLARD, M.B., D.P.H.,
Assistant Medical Officer of the Government and Acting Microbiologist,
from material supplied by Dr. Woolnough, of Kempsey, and Sanitary Inspector Lloyd (Cert. R. San. I.).

PART I.

General Description of Kempsey.

Kempsey is situated on the Macleay River (Lat. 31 S.), about 200 miles north of Sydney, and about 30 miles from the sea coast. The town, which was incorporated in 1886 as a borough, having an area of 1,051 acres, is divided into East, Central, and West Kempsey. East Kempsey, on the right bank of the river, is comparatively elevated, and is occupied in the main by residences. Access is afforded by a bridge across the river. Central Kempsey, on the left bank of the river, is the business portion of the town. West Kempsey, also on the left bank of the river, is about 1 mile from Central Kempsey, and is mainly occupied by residences and farms.

Population and Dwellings.—At the Census of 1901 the population of the municipality was 2,329, and the houses 453, of which 416 were wooden, 31 of brick, and 6 of other materials. The figures in 1907 are estimated to be approximately the same. The buildings are, generally speaking, old and structurally defective, and in the lower-lying parts of the town are commonly raised from the ground to escape flood-waters.

Topography and Soil.—The town is situated on both sides of a large horseshoe bend of the river, the two banks being connected by a bridge as above stated. Except in East Kempsey, the site is almost flat and low-lying, and on this account subject to periodical flooding by the river. The soil is a rich loam. The village of Greenhills is situated about 3 miles upstream, and Frederickton and Smithtown 4 and 12 miles respectively downstream from Kempsey.

Products and Communications.—Dairy-farming, maize-growing, and timber-getting are the principal industries of the district. Communication with Sydney is maintained by the North Coast Steam Navigation Company's s.s. "Ramornie," and N. Cain's Coastal Co-operative Company's s.s. "Hastings," each making one trip to and from Sydney every five days. Other steamers of both companies make occasional trips, as required, for cargo. A local steamer, the "Olga," plies daily up and down the river carrying passengers and deck cargo between the numerous river wharves.

Sanitary Circumstances and Administration.—Very little regard has in the past been paid to sanitary matters. Cesspits abound in the town, and with very few exceptions they are mere holes in the ground, at best with slabbed walls. Nor is there any regular service for emptying them. Where closet pails are used they are of the most diverse descriptions, such as kerosene tins, oil drums, butter boxes, biscuit tins, wash-tubs, &c.; and individual householders use their own discretion as to when, where, and how they dispose of the contents. Although the municipality was included in the original proclamation under the Nuisances Prevention Act, no bylaws under this Act have been made. Many closet buildings were found to be ruinous, and minor defects were numerous. The administration of the Public Health Act also has been almost a dead letter. There was an Inspector of Nuisances at 15s. per week, but he was aged, ignorant, and inefficient.

PART II.

Plague in Man.

In all, 4 cases occurred at Kempsey, concerning whom brief clinical and epidemiological details are given below. It will be noted that the first case was that of a man who had been employed in a produce store, where, on 16th and 17th January, six or seven days before the date of his attack on 23rd January, he had assisted at the removal and destruction of 31 dead rats which were found beneath one of the floors. It is stated that rat poison had been laid at this store on 31st December; but the period that had elapsed since this date, and the number of rat carcases found, make it most probable that these rats had died of an epizoötic rather than of poison. As the carcases were destroyed without examination, this point must remain undecided. This patient had symptoms of lobar pneumonia from the onset of his illness, and developed multiple buboes five days later, a few hours before his death. Though the pneumonia in this case is said to have been lobar, and as such not of the type usually found in pneumonic plague, yet as the sputum was not bacteriologically examined, it cannot be positively stated that this was not a case of pneumonic plague with secondary buboes.

He was nursed at the residence of his sister, and by her. This sister and her daughter (Cases C and B) next became ill, on 1st February and 29th January respectively, the former with pneumonic, the latter with septicæmic plague. Here there was a double possibility that these cases may have been infected either from contact with Case A, if he did have pneumonic plague, or by frequenting the presumably infected produce store.

Cases B (Rachael Maclean) and C (Mrs. Maclean) were both removed to the Kempsey Hospital on 1st February, and there died—Mrs. Maclean on 4th February and Rachael on 12th February. In the hospital they were attended by the matron and two other nurses, and on 6th February the matron (Case D) was attacked with pneumonic plague, from which she died on 11th February. As to the last case, there seems to be no reasonable doubt that she was infected from Mrs. Maclean. It is stated that the precautions against infection prescribed by the medical attendant were not strictly observed by the matron, and that on one occasion at least Mrs. Maclean is known to have coughed into the latter's unprotected face.

The following are details of the circumstances connected with these 4 cases of plague.

Case A.—Russell, Thomas James Joseph.

Summary.—Male, æt. 31 years; single; employed in Maclean's produce store, Belgrave-street. No former attack; never inoculated; no communication with any previous case. Resided in Clyde-street. Attacked 23rd January, died 29th January, 3 a.m. Pneumonic (?) plague, with cervical and double inguinal buboes. Morphological, cultural, and inoculation tests of bubo juice positive.

Movements prior to Attack.—Had not been away from Kempsey. Was regularly employed at Maclean's produce store.

History of Illness.—Taken ill suddenly on the morning of 23rd January with rigor. Temperature 103° F., pulse 120, respiration 16. Next day respiration more rapid, and definite pneumonia at left base. After this the clinical course was that of a typical lobar pneumonia until the evening of 28th January, when he became worse, with rapid pulse, and was evidently in a very grave condition. At this time it was observed that the glands of both groins and of the right side of neck had become enlarged and very tender. At 10 p.m. temperature was 105° (it had been 103° in the morning), pulse 144, and respiration very rapid and stertorous. He died at 3 a.m. on 29th January. Throughout his illness he remained at his residence, and was nursed by Mrs. Maclean (Case C). On post-mortem examination the same morning the inguinal glands and surrounding tissues were found to be infiltrated and hæmorrhagic.

Residence.—A detached four-roomed cottage in Clyde-street, in fair repair, and in cleanly condition.

Employment.—Maclean's produce store, Belgrave-street. A one-storied wooden building, containing in all 5 rooms. From under the floors of this store, five dray-loads of rubbish were removed during cleansing operations, 2nd–6th February.

Rats at Place of Employment.—About the latter end of December, 1906, rats in considerable numbers were seen about the premises. On 31st December poison was freely laid. For the following week rats were still seen about the place, but after this no more were seen. About 14th January an offensive smell was noticed in the small store, and on that date a small portion of the flooring was raised and 1 dead rat removed from underneath. On 16th and 17th January the whole floor of the small store was removed by Maclean and the patient, and rat burrows were dug out. On this occasion 31 dead rats were found. Since then rats have not been seen or heard by the occupier. When the premises were cleansed and disinfected by the Departmental Sanitary Inspector (2nd-6th February), burrows were found beneath the floors, indicating recent rat infestation, but only 1 rat was seen. This rat was killed, and no sign of infection was found in it. At residence: When the residence was cleansed and disinfected (7th–10th February), previous rat infestation was indicated by burrows leading to the cesspit, and 3 rats were found, namely, 2 skeletons and 1 putrid carcase.

Contacts.—Patient, being a brother of Mrs. Maclean, lived with the Maclean family. During his whole illness he was nursed at the residence by Mrs. Maclean. Other members of the household were Mr. Maclean, Rachael, aged 11 years, and John, aged 9 years. Of these persons, Mrs. Maclean and Rachael subsequently became infected (Cases C and B).

CASE B.—MACLEAN, RACHAEL ANN.

Summary.—Female, æt. 11 years; single; school girl. No former attack; never inoculated. Resided at same address as Case A. Attacked, 29th January; died, 12th February. Septicæmic plague.

Movements prior to Attack.—Had not recently been away from the district. Was in the habit of spending a good deal of her time at her father's produce store, where her uncle, J.R. (Case A), was employed.

History of the Case.—On 29th January was taken ill with headache and nausea. When seen by Dr. Woolnough on 1st February, had temperature 103° F., pulse 130, weak and dierotic, headache, nausea, and general malaise. She was admitted to the Kempsey Hospital the same day. On 5th February she was much worse, had a rigor, and at 11 a.m. her temperature was 105° F. Her temperature continued high, and general condition bad, until her death on 12th February. No pneumonia nor bubo developed.

Residence, Rats, and Contacts.—See Case A.

CASE C.—MACLEAN, BRIDGET ANN.

Summary.—Female, æt. 34 years; married; wife of produce merchant. No former attack; never inoculated. Resided at same premises with Cases A and B, being sister of Case A and mother of Case B. Nursed Case A throughout his illness at their residence. Attacked, 1st February, 10 a.m.; died, 4th February, 4 a.m. Pneumonic plague. Morphological, cultural, and inoculation tests (of sputum) positive.

Movements prior to Attack.—Had not been away from house; had been to produce store occasionally. Had nursed Case A in his illness.

History of Illness.—Taken ill suddenly on 1st February, at 10 a.m., with rigor and collapse; temperature, 104° F.; pulse, 136, weak and dierotic; extremities, blue and cold. Sent at once to Kempsey Hospital. 2nd February—Temperature 104·5° F. and definite broncho pneumona. 3rd February—Pneumonia, further developed; sputum, bloodstained; pulse, 156, and intermittent. 4th February—Died at 4 a.m., after an illness of 66 hours.

Residence and Rats.—See Case A.

Contacts.—At the hospital, whither she was conveyed within about 1 hour of her attack, she was attended by Dr. Woolnough, nursed by the matron and two other nurses, and was visited by her husband. Of these persons, one (the matron) became infected (Case D).

CASE D.—GULLIFORD, MARY.

Summary.—Female, æt. 35; single; matron, Kempsey Hospital. No former attack; never inoculated. Nursed Cases B and C. Attacked, 6th February, 11 a.m.; died, 11th February, at 1 p.m.

Movements prior to Attack.—Had not been away from district.

History of Illness.—6th February—Taken suddenly ill about 11 a.m. with rigor; pain in chest; and temperature 103° F. 7th February—Well-marked pneumonia at right apex; temperature and pulse rising. These symptoms continued, her condition grew increasingly grave, and she died on 11th February, about 1 p.m.

Residence.—The patient lived in a four-roomed wooden cottage at the Kempsey Hospital, which was in good repair and cleanly kept.

Rats.—Some rat burrows were found beneath the hospital kitchen, and 1 rat was trapped there, but was found to be non-infected.

Contacts.—During her illness the patient was attended by Dr. Woolnough and two nurses, none of whom became infected.

PART III.

PLAGUE IN RATS.

Many vague statements were rife as to rats having been unusually numerous in Kempsey in the latter part of December, 1906, and the beginning of January, 1907, but no rat mortality appears to have been observed until, as above stated, Maclean found 31 dead rats beneath his produce store on 11th January.

As soon, however, as the diagnosis of Case A had directed attention to the matter, definite evidence was obtained of epizoötic plague in the Kempsey rats. On 29th January Dr. Woolnough found in his stable a dead rat, which he describes as having "liver and spleen enlarged and hæmorrhagic, bloodstained fluid in the peritoneal cavity, and injection of intestines." No bacteriological examination was made, but this description suggests strongly that the rat was plague-infected. Dr. Woolnough had recently received chaff and other horse-feed from Maclean's produce store. On 1st February, at "Tattersall's Hotel," and at O'Halloran's adjoining premises, in Belgrave-street, in the same block as Maclean's produce store, but about 150 yards nearer the river bank, 4 dead rats were found, which were subsequently proved, by cultural and inoculation tests, to be plague-infected. When these premises were dealt with by the cleansing gang (2nd–8th February) 41 dead rats were found (mostly putrid, and therefore unfit for bacteriological examination), in addition to 33 rats that were killed or trapped. On 5th February, at Barnett's "Victoria Hotel," also in Belgrave-street, and nearly opposite to "Tattersall's Hotel," 1 infected rat was found in the yard, and subsequently 3 putrid rats. On 6th February 1 infected and 2 putrid rats were found on Ramsay's premises, in Belgrave-street, about 50 yards west of Maclean's store. On 8th February, at Fern's stables in John-street, about 100 yards south of Maclean's store, 1 infected rat was found. On 10th February, at Sydenham's premises, in Belgrave-street, next door to Ramsay's, 1 infected rat was found dead. There was then an interval of seven days till the finding, on 17th and 18th February, of 4 infected and 12 putrid rats at the North Coast Steam Navigation Company's wharf on the river bank. After this no more infected rats were found.

Thus, altogether, seven premises were found to be harbouring infected rats, infection being positively demonstrated in 12 rats from these places, and on some other premises evidence was obtained of previous rat mortality.

The following table summarises the above facts, and shows the chronological relations of the occurrence of cases, and finding of infected rats:—

TABLE A.

	Infected Rodents.					Other Rodents found dead.
	Rats.	Mice.	Total.	First.	Last.	
Maclean's produce store	...	...	...	......	......	31 rats on 16-17 Jan.
Dr. Woolnough's stable	...	...	...	......	......	1 rat on 29 Jan.
Case A, attacked 23rd January.						
„ B „ 29th „						
„ C , 1st February.						
"Tattersall's Hotel," Belgrave-street ...	3	...	3	1 Feb.	6 Feb.	41 rats, 2–8 Feb.
O'Halloran's premises (adjoining)	1	...	1	1 „	......	
"Victoria Hotel," Belgrave-street, ...	1	...	1	5 „	......	3 rats, 5 Feb.
Case D, attacked 6th February.						
Ramsay's saddler's shop, Belgrave-street ...	1	...	1	6 „	......	2 „ 6 Feb.
Dr. Lancaster's yard (adjoining Ramsay's)	...	...	...	......	......	2 „ 6 „
Fern's stables, Belgrave-street	1	...	1	8 „	......	1 rat, 8 „
W. Sydenham's premises, John-street ...	1	...	1	10 „	......	
N.C.S.N. Co.'s wharf	4	...	4	17 „	18 Feb.	12 rats, 17–18 Feb.

From 1st February to 5th March a systematic examination was made by Dr. Woolnough of all rats and mice obtainable in Kempsey. In the case of any in which he suspected plague infection, he made smears and cultures, and subsequently these were examined at the Board's laboratory to confirm the diagnosis. In all 514 rodents, namely, 455 rats and 59 mice, were thus examined. Of these, 331 were obtained in Central Kempsey, the rest in other parts of the municipality. The following table shows the number examined and the number found to be infected each week:—

TABLE B.

Week ending—	Examined.			Infected.	
	Rats.	Mice.	Total.	Rats.	Mice.
7 February, 1907	176	6	182	6	...
14 „ „	167	46	213	2	...
21 „ „	88	4	92	4	...
28 „ „	19	3	22	...	...
7 March, „	3	2	5	...	...
Total	453	61	514	12	...

In regard to the epizoötic, the most noteworthy circumstance is that it appears to have been confined to a limited area in the neighbourhood of Maclean's produce store. With the exception of the N.C.S.N. Company's wharf on the river bank, not one of the places which yielded infected rats was more than 100 yards from the produce store. It is, no doubt, possible that there were infected rats which were not submitted for examination, but it is not likely that there were many, for a very thorough search was made throughout Central Kempsey. One hundred and sixty-four premises were thoroughly searched by the cleansing gangs, and, in addition, diligent inquiries were made throughout the town as to the occurrence of any rat mortality. Similar inquiries were made by the police in the district surrounding Kempsey, with uniformly negative results.

As to the source whence the infection was carried to Kempsey, there can be little doubt that it was carried from Sydney in produce or other merchandise. Maclean received frequent consignments of horse-feed from Sydney. His books showed that in the month of December, 1906, he had received 393 bags of chaff from produce merchants in Sussex-street, Sydney. Infected rats were taken at the Federal Wharf, Sydney, which is in the vicinity of the premises whence the chaff was supplied, on 19th November, 11th December, and 12th December. The finding of infected rats at the N.C.S.N. Company's Kempsey wharf on 17th and 18th February, may probably be accepted as a further indication of the path by which the infection was conveyed to Maclean's store.

PART IV.

ADMINISTRATIVE MEASURES.

Immediately on receipt of news of the positive diagnosis by Dr. Woolnough of Case A as plague, Sanitary Inspector Lloyd, of the Departmental staff, who had had much previous experience in plague work, was despatched overland to advise the Local Authority (the Municipal Council) as to the action necessary to be taken to deal with the outbreak. He took with him a skilled rat-catcher, and also the necessary outfit for bacteriological examination of infected material. The latter work was undertaken by Dr. Woolnough, of Kempsey, who was formerly a medical officer of the Coast Hospital, Sydney, and while there had charge of the plague wards. At Kempsey he had medical charge of the 4 cases, and also examined all rats brought in by cleansing gangs or by private individuals.

Cleansing and disinfection of premises was carried out as in other outbreaks elsewhere in the State. The work was begun on 2nd February, and continued until its completion on 6th March. It may be summarised as follows :—

Premises searched and cleansed...	164
Drayloads of rubbish removed	205
Premises cleansed by occupiers	45
Expenditure	£243

By Executive Minutes dated 4th February and 6th February, 1907, the Board of Health was authorised :—

1. To take whatever action may be considered necessary for the cleansing and disinfection of Maclean's produce store.
2. To prevent the removal of grain and fodder from stores in Central Kempsey until such premises have been thoroughly searched for the presence of rats.

Immediately on the diagnosis of the first case the Kempsey Municipal Council caused a 6-feet galvanized iron fence to be erected, enclosing Maclean's produce store, with the view of preventing egress of rats, but in the cleansing of these premises (2nd-6th February) only 3 rats were obtained, 1 being killed by the gang and the other 2 found dead and putrid.

Accommodation of Patients.—Case A was treated at his own residence and died there. The others were treated at the Kempsey Hospital, Cases B and C in the isolation cottage, and Case D (the matron) in her own cottage.

The

PREPARED FOR THE DEPARTMENT OF PUBLIC HEALTH.

MAP
OF THE
TOWN OF KEMPSEY.

Showing the places at which plague-infected rodents were taken in 1907, the places at which persons who had plague were employed, and the places where they resided.

NOTE.—Places at which plague-infected rodents were taken—consecutively numbered in accordance with the date on which the first was taken at each place—are shown thus ●5

Places at which persons who had plague resided

Shewn thus Ⓐ

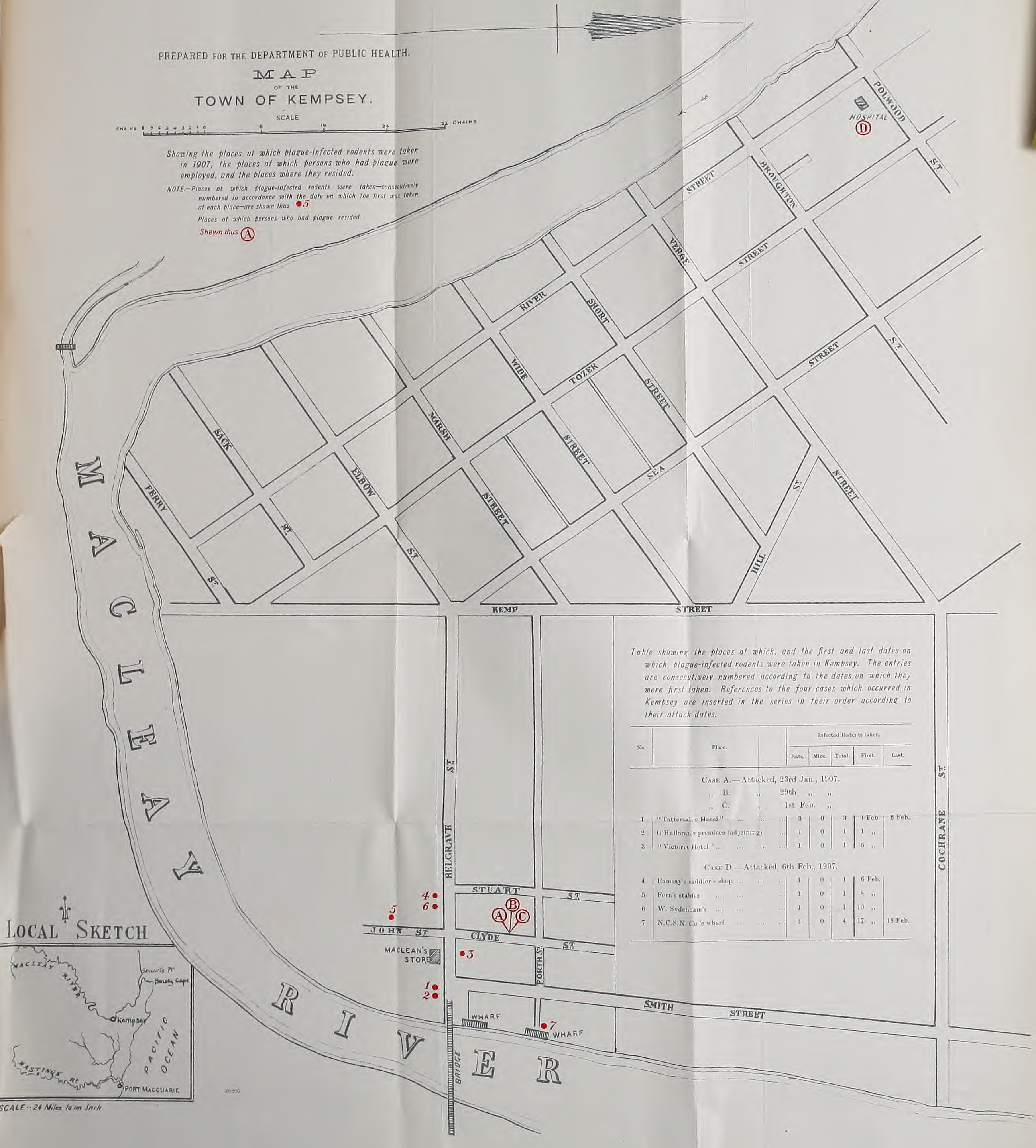

Table showing the places at which, and the first and last dates on which, plague-infected rodents were taken in Kempsey. The entries are consecutively numbered according to the dates on which they were first taken. References to the four cases which occurred in Kempsey are inserted in the series in their order according to their attack dates.

No.	Place.	Infected Rodents taken.				
		Rats.	Mice.	Total.	First.	Last.
	CASE A.—Attacked, 23rd Jan., 1907.					
	,, B. ,, 29th ,, ,,					
	,, C. ,, 1st Feb. ,,					
1	"Tattersall's Hotel"	3	0	3	1 Feb.	6 Feb.
2	O'Halloran's premises (adjoining) ...	1	0	1	1 ,,	
3	"Victoria Hotel"	1	0	1	5 ,,	
	CASE D.—Attacked, 6th Feb., 1907.					
4	Ramsay's saddler's shop	1	0	1	6 Feb.	
5	Fern's stables	1	0	1	8 ,,	
6	W. Sydenham's	1	0	1	10 ,,	
7	N.C.S.N. Co.'s wharf	4	0	4	17 ,,	18 Feb.

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TROPICAL
DISEASES
19 JUN. 1923
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The Mayor (Alderman A. C. Small) and the Town Council acted with unusual energy and intelligence, and to this the summary extinction of the outbreak is largely ascribable. Their operations were directed in general by Dr. Woolnough, formerly Senior Resident Medical Officer, Coast Hospital, who was appointed by the Board to be its local representative, and in executive work by Mr. Lloyd (Cert. Royal Sanitary Institute), one of the Sanitary Inspectors attached to the Central Department of Public Health. At a certain date the Medical Officer of Health, Hunter River Combined Sanitary Districts (Dr. R. Dick, M.B., D.P.H.), was directed by the President (Dr. J. Ashburton Thompson) to pay a flying visit of inspection for further information of the Board.

APPENDICES.

APPENDIX A.

NOTE.—It is to be understood that none of the patients mentioned below had had any former attack of plague, had at any time been protected with Haffkine's prophylactic or otherwise, nor had had any communication with cases which preceded theirs, unless the contrary is stated.

Consecutive numbers are assigned in order of date of notification; capital letters connect the cases with the Diagrams; "d" following capital letters means "died."

CASE 1 (A).

Summary.—B.M.E., m., æt. 21, single, clerk. Residence, Five Dock; employment, W. M. Cameron & Co., 20, Barrack-street, City. Notified by Dr. Allen, 8th January, 11 a.m. Visited (Dr. W. G. Armstrong, M.B., D.P.H., Medical Officer of Health, Metropolitan Combined Districts), 2 p.m.; admitted to Coast Hospital, 8 p.m.; discharged, 6th February; duration of illness, 30 days. Left femoral bubo of the size of an almond; extremely tender; films and cultures positive. Lesions of drainage area, a perfectly healed abrasion of left shin, said to have been inflicted on 26th December while bathing.

Movements before Attack.[*]—His work does not take him out of his office, and has been nowhere but between his office and home since 1st January, when he visited a theatre.

Attack.—Having gone to bed in good health, awoke on 7th January with malaise, headache, and pain in the groin. Went to his office, but was obliged to go home again very soon.

Residence.—A detached wooden cottage in good repair, clean; pail closet; no trade; no stable, and none near.

Employment.—A warehouse, in which dried fruits and hops stored; in a terrace, brick, three stories and basement. An old building in fair repair.

Rats.—At residence, no traces; at employment, the lower part of the wall in the basement was perforated by rats, and there were abundant traces of past infestation, but only 2 rats and 1 mouse (all of which were negative), and 1 dried carcase, were collected.

Connected Cases.—None.

CASE 2 (D).

Summary.—W.D.S., m., æt. 32, contractor, married. Residence, 22, Newland-street, Waverley; employment, was engaged in dismantling Sargent's restaurant premises at 80, King-street, City, preparatory to reconstruction; last attendance, 17th January. Notified by Dr. Walton Smith, 18th January, 10 a.m.; visited (Assistant Medical Officer of Government, Dr. R. J. Millard, M.B., D.P.H.), 11 a.m.; admitted to Coast Hospital, 4 p.m.; discharged, 23rd February; duration of illness, 37 days.

Movements before Attack.—From the tenth day to the sixth before attack was superintending alterations at 11, Hunter-street (plague-free premises); on the fifth day stayed at home; on the fourth day began work at 80, King-street, and continued.

Attack.—Worked all day 17th January; felt unusually tired during evening; went to bed at 9 o'clock, and then discovered tenderness in left groin. On 18th, morning, was found to have a small left femoral bubo; tender. Films and cultures made with material then withdrawn, negative; cultures made with the same taken 21st, negative; the same 22nd, cultures and inoculation, positive. Lesions of drainage area, two flea-bites on left thigh. A blood-film made 18th showed presence of well-marked neutrophile leucocytosis.

Residence.—No note.

Employment.—The premises, in the heart of the city, which he was dismantling, were a three-storey brick building in good repair, with an extensive, light, and well-fitted basement used by customers; the basement had a 4-foot wainscoting of matched boarding, which afforded ample signs of infestation with rats. At back the premises opened on a branch of Bank-court.

Rats.—The basement (as above) and the upper floors all presented evidence of present infestation. On 15th January patient found 2 dead rats, which were burnt without being submitted; but on 10th January, 3, and on 15th, 1 plague-infected carcases had been collected in Bank-court.

Connected Cases.—With the patient, none; with the locality in which he worked, see account of the Bank-court group in the text.

CASE 3

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[*] The statement under this heading extends in every case to the ten days which preceded the day of attack.

Case 3 (I).

Summary.—H.M., m., æt. 37, plumber, married. Worked on the same premises as Case 2. Residence, Mitchell-street, St. Leonards; employment, was engaged in dismantling 80, King-street, City; last attendance, 23rd January. Notified from the Coast Hospital, where he presented himself 23rd January, 11 a.m.; discharged, 19th February; duration of illness, 27 days. Left femoral bubo; films negative, cultures and inoculation, positive. Lesions of drainage area, a few small healed abrasions, and a few lesions of the size of a pin's head, which may have been flea-bites.

Movements before Attack.—Had been employed at Sargent's dismantled restaurant premises, at 80, King-street, for nine days before attack, and had visited another shop under the same management twice, four days and one day before attack. Also visited a rifle range on the fourth day before attack.

Attack.—Was well on 22nd. On rising at 5·30 a.m., 23rd, noticed a small, tender swelling in the left groin; went to work; nausea prevented him from taking food; ceased work at noon, and went to the Coast Hospital, ostensibly to visit W.D.B., but sought advice for himself and was detained. On admission looked rather ill; flushed; conjunctival injection; p. 112, compressible; the bubo was then the size of a marble, moderately tender, and there was already some periadenitic effusion.

Residence.—No note.

Employment and Rats.—See Case 2.

Connected Cases.—With the patient, none; with the locality in which he worked, see account of the Bank-court group in the text.

Case 4 (G).

Summary.—H.W., m., æt. 30, cook, single. Residence, 206, Cumberland-street, City; employment, Sargent's restaurant, 390, George-street, city; last attendance, 22nd January. Notified by Sydney Hospital, 25th January, 3·30 p.m.; visited (R.J.M.), 4·15 p.m.; admitted to Coast Hospital, 26th, mid-day; discharged, 28th February; duration of illness, 37 days. Large left femoral bubo filling Scarpa's triangle, skin reddened; films, cultures, and inoculation, positive. Lesions of drainage area, several minute abrasions and flea bites.

Movements before Attack.—At home and at work. Tenth day, before attack, visited a public park; ninth day, worked for an hour at removing utensils from 80, King-street (see Cases 2 and 3); otherwise worked at the George-street building.

Attack.—22nd January—On leaving work at 8 p.m. first noticed swelling and sudden stiffness in the left groin; at 9·30 had a rigor and vomited; passed a restless night; occipital headache. 23rd—Stayed in bed, but got up in the afternoon; headache, vomiting, giddiness, and increased size of bubo; restless night. 24th—The same symptoms, plus depression of spirits, marked thirst, and offensive taste; visited the Botanical Garden during the afternoon; restless night. 25th—Admitted to Sydney Hospital.

Residence.—An old but good house in process of renovation.

Employment.—See general account of the Bank-lane group, to which this case belonged, in the text.

Rats.—At residence, the conditions mentioned above prevented detection of the usual state. At employment, see the general account.

Connected Cases.—With the patient, none; with the locality in which he worked, see Bank-court group, in the text.

Case 5 (F, d).

Summary.—V.M.S., f., æt. 19, single, draper's assistant. Residence, 31, Yule-street, Petersham; employment, Waters & Co., 394, George-street, City. This patient, who was subject to fits of some sort, fell ill while at work 21st January. She was first seen by Dr. T. W. Lipscomb on 24th January, and she died early on 26th January. Her case was notified after her death, and her body was removed to a public mortuary, where a *post-mortem* examination was made by the Second Government Medical Officer for Sydney (Dr. G. H. Taylor), who forwarded specimens taken from the spleen and from the cervical glands on the left side, which had become tumefied on 25th January. Films, cultures, and inoculation, positive.

Residence.—Brick cottage, detached, one storey, 5 rooms, connected with sewers; repair and cleanliness, fair, but damp.

Rats.—At residence, no signs; many fleas. At employment, see general account of the back lane group, in the text.

Note.—See also the account of the Yule-street group, with which this case was connected, in the text.

Cases 6 and 7 (B, d, and C, d).

The illness from which these two patients suffered and died was registered as "pneumonia." The physicians in attendance upon them subsequently agreed that it had probably been primary plague pneumonia. Associated cases were Mrs. Lock's and Ma Kong's (Nos. 8 and 9, below), which formed the Campbell-street group.

Case 6.—Thomas Chong Wing On worked for Lock (also Chinese) as foreman, buyer, &c., in the produce trade. He lived at an unnumbered house in Parker-street, close by Campbell-street. His business caused him to frequent the produce wharves at Darling Harbour, which were known to be infected at the time of his attack. 9th January—Was married to a sister of Mrs. Lock (Case 8); in the afternoon went to Manly by water for the honeymoon; was taken ill on board the boat. 10th January—Was visited by a medical man. 12th January—Seemed a little better. 13th January—Died. Registered cause of death, pneumonia.

Case 7.—Mrs. May Chong Wing On, wife of Thomas Chong Wing On. She was in close attendance on her husband during the whole of his illness. 15th January—Fell ill in the evening. 16th January—Was visited by medical man; she had a T. 106°, and was vomiting. 17th January—Was removed to a private hospital. 19th January—Died at 2·30 p.m. Her sister, Mrs. Lock (Case 8), was almost constantly with her during the whole of her illness.

Connected Cases.—Nos. 8 and 9; see account of the Campbell-street group in the text.

Case 8

CASE 8 (H, d).

Summary.—K.L., f., æt. 22, housewife, married. An Australian native, born of Chinese parents. Residence, 24, Campbell-street, City. Was sister to Mrs. Chong Wing On (Case 7). Notified by Dr. Sawkins, 26th January; visited (W.G.A.), 11 a.m.; admitted to Coast Hospital, 9 p.m; died, 27th January; duration of illness, about 6 days. No bubo; films made with peripheral blood on 26th, negative. *Post mortem.*—Lungs normal; cultures made from liver and spleen positive, from heart's blood, negative; inoculation, positive. Delirium was excessive, though not maniacal.

Movements before Attack.—Probably the patient remained at home during the ten days before her attack, save when she attended her sister, Mrs. Chong Wing On (Case 7), who died of plague, 19th January. To private hospital, 24th January.

Attack.—She sought advice on the 24th; she said she had caught cold at her sister's funeral on the 21st.

Residence.—A good brick terrace house, occupied, as to the first floor, by patient, in other part as lodging-room for 9 Chinese labourers, and in other part as a store for bananas, pea-nuts, maize, rice, &c., in which her husband traded.

Rats.—At residence, which was new and in good condition, no basement, ground-floor concreted, there were two rat-holes on the first floor which appeared to be old, and there were no signs of present or past infestation.

Connected Cases.—See account of the Campbell-street group, to which this case belonged, in the text.

CASE 9 (J).

Summary.—Ma Kong, m., æt. 28, labourer, single. Residence and employment, 24, Campbell-street, City. Notified from Callan Park Asylum, 26th January, 11 a.m.; visited (R.J.M.), 2·15 p.m.; admitted to Coast Hospital, 9 p.m.; discharged, 2nd April; duration of illness, about 70 days. Left femoral bubo; films and culture-positive. Lesions of drainage area, several not recent scratches and abrasions on the leg.

Movements before Attack.—No history could be got, but see below.

Attack—The patient was in apparent good health when, on the morning of 25th January, he suddenly became excited and violent, and attacked his housemates with an axe. The police were called in, and removed him to the Reception House, where he continued violent until late in the afternoon. The Second Government Medical Officer for Sydney (Dr. G. H. Taylor) visited the Reception House in the ordinary course of duty, and reported that he was then quiet, in a state of abject terror, and under delusions of persecution; he had no fever, and the cause of a large femoral bubo was not inquired into. The same day he was transferred to an Asylum for the Insane. On 26th January he was reported thence to be quiet and rational, and to have a bubo for which no external cause could be found; examination with plague in view was requested. Two other medical men who examined him during the violent delirium saw no sign of general disease, and thought him insane. At discharge from hospital he was perfectly sane.

Residence and Employment.—See Case 8.

Rats and connected Cases.—See account of the Campbell-street group, to which this case belonged, in the text.

CASE 10 (E).

Summary.—V.B., m., æt. 39, married, lift-man. Residence, 39, View-street, Woollahra; employment Sargent's restaurant, 290, George-street, City. Notified by his employer, 28th January, 9 a.m.; examined by the Assistant Medical Officer of Health, Metropolitan Combined Districts, 10 a.m.; admitted to Coast Hospital, 1 p.m.; discharged, 10th February; duration of illness, 23 days. Right femoral bubo, quiescent at date of examination; films and culture, negative.

Movements before Attack.—Was either at work or at home for ten days before attack.

Attack.—Was suddenly attacked at 4 p.m., 18th January; headache, vertigo; bubo first observed about 24 hours later; stayed at home (in bed for 2 or 3 days only) until 28th; on returning to work was then desired by his master to report himself.

Residence.—A brick cottage of 5 rooms, in a terrace, clean, in good sanitary state, connected with sewers; no stables near.

Employment.—See account in the text of the group to which this case belonged.

Rats.—At residence, no signs; at employment, see account in the text.

Connected Cases.—With the patient, none; with his place of employment, see account of the Bank-court group in the text.

CASE 11 (M).

Summary.—G.E., f., æt. 17, single, waitress. Residence, George-street, Burwood; employment, Sargent's restaurant, 390, George-street, City. Notified by Dr. Blaxland, 27th January, 9 p.m.; visited (R.J.M.), 9·30 a.m., 28th January; admitted to Coast Hospital, 6 p.m.; discharged, 24th February; duration of illness, 28 days. No definite bubo, but there was some fulness of the left cervical region; films made 28th, negative; cultures, no growth. Peripheral blood taken 29th and 4th February, films and cultures negative.

Movements before Attack.—Between home and employment only.

Attack.—26th was well, but very tired at night; at waking 27th, giddy, vomited; at 11 a.m., T. 103°; in the afterpart of the day became dull, and eventually semi-comatose; T., 8 p.m., 105°.

Residence.—Detached brick cottage, clean, good sanitary state, connected with sewers; no stables near.

Employment.—See account in the text.

Rats.—At residence, no signs; employment, see text.

Connected Cases.—With patient, none; with her place of employment, see account of the Bank-court group in the text.

CASE 12

CASE 12 (N).

Summary.—L.C., f., æt. 17, single, waitress. Residence, 96, Sutherland-street, Paddington; employment, Sargent's restaurant, 390, George-street, City. Notified by Dr. Walton Smith, 28th January, noon; visited (R.J.M.), 12·45 p.m.; admitted to Coast Hospital, 6 p.m.; discharged, 17th February; duration of illness, 22 days. Bubo just above Poupart's ligament in the right groin; small, and so tender that it could not be punctured. Blood drawn from a finger-tip yielded negative results on direct and cultural examination.

Movements before Attack.—Between home and employment only.

Attack.—26th, well; 27th, rigor at 5 a.m., severe abdominal pain, accompanied later by severe headache and backache; at 11 a.m. T. 104°, and at 8 p.m. 105°; 28th, 5 a.m., 105°, groin became painful.

Residence.—Two-storey brick house, in terrace, good sanitary state, connected with sewers; no stables near.

Employment.—See account in text.

Rats.—At residence, signs of past infestation in the shape of burrows beneath the dividing fence; the adjoining premises on one side were said to be extensively rat-infested. At employment, patient had seen and heard of many dead rats, but had not touched them.

Connected Cases.—With patient, none; with place at which she worked, see account of the Bank-court group in the text.

CASE 13 (K).

Summary.—L.D., f., æt. 17, single, a waitress. Residence, 3, Little Wyndham-street, Alexandria; employment, Sargent's restaurant, 390, George-street, City; last attendance, 24th January. Notified by absence from place of employment, 28th January; visited (T.W.S.), 2·30 p.m.; admitted to Coast Hospital, 6 p.m; discharged, 17th February; duration of illness, 24 days. Right inguinal bubo, marked tenderness, no pain, moderate periadenitic effusion; films, cultures, and inoculation, negative. Lesions of drainage area, none.

Movements before Attack.—Between home and employment only.

Attack.—Having been well 24th, was suddenly attacked 25th, 7 a.m., with headache and general pains; the groin was first noticed to be tender, 27th. At examination, 28th, P. 84, R. 20, T. 100·2°, dull and torpid, conjunctivæ injected, pupils dilated, arterial tension low; extreme tenderness of the bubo prevented abstraction of liquid from it till 30th January (see above).

Residence.—Wooden cottage, detached, clean, good sanitary state, connected with sewers; no stables near.

Employment.—See text.

Rats.—At residence, one hole in passage was the only evidence of past infestation. Employment, see text.

Connected Cases.—With patient, none; with place at which she worked, see account of the Bank-court group in the text.

CASE 14 (L, d).

Summary.—E.F., m., æt. 27, single, working jeweller. Residence, 258, Liverpool-street, City; employment, Flegeltaub, jeweller, 96, King-street, City; last attendance, 26th January. Notified by Dr. Hall, 30th January, noon; visited (R.J.M.), 12·30 p.m.; admitted to Coast Hospital, 5 p.m.; died 2nd February; duration of illness, 8 days. No bubo; no cough or sputum; blood from right middle finger, 30th, film negative; culture and inoculation, positive; blood from right ear, 31st, film negative, culture overgrown, inoculation positive.

Movements before Attack.—Between home and employment only.

Attack.—25th, was well; 26th, suddenly attacked, 8·30 a.m., giddy and weak on his way to work, vomiting, headache; returned home, has been in bed ever since. Form, septicæmic; on 1st February a soft, diffuse, swelling appeared below left ear, which was afterwards found to enclose a swollen cervical gland surrounded by moderate effusion, in which *B. pestis* in number were demonstrated in films, and obtained pure in culture. Abdominal distension and tympanites, constipation, during the last 48 hours jaundice, albumen and bile in urine. *Post mortem*—Lungs, hypostatic congestion of both bases, at each apex a patch of consolidation with old pleuritic adhesions (tuberculosis); stomach contained black liquid, intestines distended, mesenteric glands not enlarged, external iliac glands enlarged to 3 or 4 times the normal size, but normal in colour, and devoid of periadenitic effusions; liver, moderately enlarged, pale, and bile-stained; spleen enlarged, but normal in colour and consistence; heart, punctate hæmorrhages in pericardium. Films made from liver and spleen were negative, but cultures yielded a positive result; lungs, films and cultures negative; left cervical gland (see above) and right inguinal gland films positive; inoculation with the gland-substance, positive.

Residence.—A good brick house, in a terrace, connected with sewers.

Employment.—Good structural condition, basement concreted.

Rats.—At residence, no signs; at employment slight evidences of infestation, 1 rat only taken, which was healthy.

Connected Cases.—With patient, none; with locality in which employed, see account of the Bank-court group in the text.

CASE 15 (O).

Summary.—D. O'C., f., æt. 7, school. Was in communication with V.M.S. (Case 5). Residence, 24, Yule-street, Petersham; school, Crystal-street; State school near by. Notified by Dr. Jenner, 7th February, 3·30 p.m.; visited (R.J.M.), 4·15 p.m.; admitted to Coast Hospital, 9·30 p.m.; discharged, 6th March; duration of illness, 29 days. Bubo: fulness and tenderness in Scarpa's triangle, right side, but no definite bubo; 8th February—Culture negative; 11th—Peripheral blood (ear) films, cultures, and inoculation, negative; 18th—Culture again made from right groin, negative. Lesions, a few marks as of old flea-bites.

Movements before Attack.—Between home and school, and playing in the street.

Attack.—5th February—Well. 6th—Complained of headache at waking, 6 a.m., vomited at 9 a.m.; in the evening pain in right groin; at 11 p.m. T. 104°. 7th—On examination P. 156, R. normal, T. 103°, prostrate; lies with right thigh flexed and rotated outwards.

Residence.—A brick semi-detached cottage, one storey with an attic, repair and cleanliness fair, connected with sewers; a poor property; no stables near.

Rats.—Sign of past infestation, one rat-hole in sitting-room.

Connected Cases.—See account of the Yule-street group, to which this case belonged, in the text.

NOTE.—See also Case 5, which was associated with the Yule-street group.

CASE 16 (P, d).

Summary.—A. O'C., f., æt. 9, school. Was in communication with V.M.S. (Case 5) and her sister, D. O'C. (Case 15). Notified by Dr. Jenner, 7th February, 3 30 p.m.; visited (R.J.M.), 4·15 p.m.; admitted to Coast Hospital, 9·30 p.m.; died 8th February; duration of illness, 56 hours. Form, septicæmic; blood from left ear taken 8th February, films, culture, and inoculation, positive.

Movements before Attack.—Between home and school, and playing in the street.

Attack.—6th February, 3·30 p.m. at school, vomited and was sent home, became feverish; at 11 p.m. T. 104°. 7th—Only semi-conscious, restless, resisted examination, face flushed, P. 144, R. normal, T. 103·2°; no other symptoms.

Residence.—See Case 15.

Residence, Rats, and connected Cases.—See account of the Yule street group in the text.

CASE 17 (Q).

Summary.—M.M., f., æt. 26, single, waitress. No former attack; not inoculated; no connection with any previous case. Residence and employment, "Empire Hotel," corner of Hunter and Pitt streets, City. Notified by Dr. Muller, 8th February, 4 40 p.m.; visited (R.J.M.), 5 p.m.; admitted to Coast Hospital, 9·30 p.m.; discharged, 27th March; duration of illness, 50 days. Right inguinal bubo; films and culture positive.

Movements before Attack.—Only left the hotel occasionally for trips on the harbour by ferry-boats to places which were not infected.

Attack.—6th February, general malaise and pains, but continued at work; 7th, worked, but felt worse; towards evening felt pain in right groin; 8th, stayed in bed; on examination, P. 140, R. normal, T. 104 8°, prostrate, face flushed, bubo very tender; some deep-seated tenderness of higher inguinal glands. Lesions, none; a small abrasion of right tibia.

Residence and Employment.—A fine stone building of four floors, with a basement or large cellar, connected with sewers, in good structural state. Domestic management: as regarded the public premises quite good; as regards servants and kitchen quarters (the latter on the fourth floor), dirty and neglected; on the roof a hut had been built, which was full of useless lumber.

Rats.—There were abundant signs of infestation in the hut on the roof, on the kitchen floor, in a staff dining-room and a store, on the third floor in a bedroom, a bathroom, and a housemaids' cupboard, on the second floor in a cupboard and in a bedroom, on the first floor in a public dining room and a pantry. Between 5th and 28th January these premises had been under notice of the Local Authority for the City by whose rat-staff 13 *M. decumanus*, 3 *M. rattus*, had been referred to the Board's laboratories, all of which had proved negative; but on 29th January 1 *M. decumanus*, and on 9th February 1 *M. musculus*, were brought in, in which plague was identified. A few putrid carcases were collected after occurrence of this case, and the patient reported that other carcases had previously been removed and destroyed.

Connected Cases.—None; another servant slept in the same room as the patient.

CASE 18 (T).

Summary.—I.R.I., f., æt. 37, married, lodger. Residence, "Standard Hotel," corner of Bathurst and Castlereagh streets, City. Notified by Dr. W. E. Warren, 12th February, 10 a.m.; visited (R J.M.), 10·30 a.m.; admitted to Coast Hospital, 3 p.m.; discharged, 6th March; duration of illness, 25 days. Right inguinal bubo, films and culture positive. Lesions, many flea-bites.

Movements before Attack.—Has lodged here about ten weeks; during ten days before attack walked occasionally in the city, and entered shops.

Attack.—10th February was in usual health till 4 p.m. when she had a rigor; went to bed at once; headache; pain in right groin first noticed during evening; at examination, P. 132, R. normal, T. 104·2°.

Residence.—An old brick public-house of 28 rooms and a basement; badly infested with fleas.

Rats.—Badly infested; many plague-rats found.

Connected Cases.—See account of the "Standard Hotel" group in the text.

CASE 19 (R).

Summary.—J.F., m., æt. 18, single, generally useful. Residence and employment, "Royal Standard Hotel." Notified by Dr. Warren, 12th February, 10 a.m.; visited (R.J.M.), 11 a.m.; admitted to Coast Hospital, 17th February, 4 p.m.; discharged, 26th March; duration of illness, 46 days. Small right inguinal bubo, moderately tender; films, negative; culture, one colony of *staphylococcus albus*; inoculation 12th February, g.-p. No. 1,443 died of plague, 17th February. Lesions, a single pustule on the back was not bacteriologically examined; on the inner aspect of the right ankle there was some tender rather soft swelling with deep redness of the overlying skin; less marked redness extended from it 2 or 3 inches up the leg; not bacteriologically examined.

Movements before Attack.—Constantly employed at the public-house, occasionally bathed at Bondi, and walked about town in his off time.

Attack.—9th February was well, but during the afternoon noticed slight soreness of the right groin; no other symptoms. 10th, evening, found slight swelling in groin. No other symptoms occurred till 16th February, when a spot at the inner side of the right ankle rather suddenly became red and swollen. No constitutional disturbance occurred throughout.

Residence, Employment, Rats, and connected Cases.—See account of the "Standard Hotel" group, in the text.

Case 20 (S).

Summary.—G.S., m., æt. 41, married, a plumber. Residence, 20, Burrapore-street, Woolloomooloo, City; employment, Thomas and Osgood, plumbers, 216, Castlereagh-street, City; last at work, 8th February. Notified by police, 12th February, 5 p.m.; visited (G.H.T.), 5·10 p.m.; admitted to Coast Hospital, 9 p.m.; discharged, 13th March; duration, 33 days. Right femoral and inguinal bubo; the femoral glands obscured by effusion and matter together, the inguinal enlarged but discrete; films and culture positive. Lesions, a few minute abrasions and pin-point stains.

Movements before Attack.—8th and 7th February worked on a job at 161–3, Oxford-street; on 6th and 5th at Usher's hotel, King-street, City; during six days before that at the Protestant Hall (which only 4 doors from "Royal Standard Hotel," Cases 18, 19, &c.).

Attack.—9th February was suddenly attacked at noon, dizziness, headache, feeling of weakness; went home, at night shivered and vomited, and during the night was slightly delirious; 11th, rather better; 12th, only moderately ill, no fresh symptoms, feeling of extreme weakness.

Residence.—A good brick cottage, connected with sewers; in fair order.

Employment.—Various places as mentioned above. See under "Rats" below.

Rats.—None actually found save at Usher's hotel, where he worked on 5th and 6th February; 8 *M. decumanas* were taken there in the ordinary course of rat-catching between 30th January and 5th February, and plague had been identified in 1 taken on 1st February; the premises were in excellent order.

Connected Cases.—None.

Case 21 (V).

Summary.—V.I., f., æt. 8, at home (daughter of I.R.I., Case 18). Notified by Dr. A. M. Johnson, 14th February, and at the same time forwarded to the Coast Hospital, where she was admitted at 7·30 p.m.; discharged, 6th March; duration, 20 days. Left inguinal bubo; inseminated agar tubes submitted by Coast Hospital, 15th and 18th February, negative; serum submitted by Coast Hospital, 19th: films negative, culture overgrown by staphylococcus. Lesions, many flea-bites.

Movements before Attack.—Was with her mother (Case 18) at the "Royal Standard Hotel"; when her mother was removed to hospital she was sent (12th February) to stay with friends at Granville, a distant suburb; removed thence to hospital.

Attack.—13th February, first sign pain in groin, 9 p.m.; slept all night; 14th, eat no breakfast, afterwards vomited, lay about all day, no other signs; on admission to hospital, P. 140, R. 38, T. 102·4°, listless, and but slightly ill; the bubo of the size of a pigeon's egg, moderately tender.

Residence, Rats, and connected Cases.—See account of the "Standard Hotel" group in the text.

Case 22 (U, d).

Summary.—G.B., m., æt. 55, servant. Residence and employment, "Royal Standard Hotel." Notified, 13th February, by the Second Government Medical Officer for Sydney (Dr. G. H. Taylor), from the Hospital Admission Depôt, where patient had personally applied; admitted to Coast Hospital, 4 p.m.; died, 21st; duration of illness, 9 days. Septicæmic form; blood taken from right ear, 21st February: films and cultures negative; inoculation, g.p. 1,450, died of plague on the ninth day. Lesions, none.

History of Illness.—12th February.—While in usual health was suddenly attacked with acute pain in the loins at 11·30 p.m.; afterwards headache, shivering, no sleep. Got up at 5 a.m. 13th, but was unable to work. *Post mortem.*—At anterior border of right lung was a solid and hæmorrhagic patch which measured about 2 in. x 1 in., but the lungs were otherwise not affected; liver, much enlarged and studded on surface and throughout substance with hæmorrhagic infarcts about one-fourth of an inch in diameter; spleen, much enlarged, parenchyma dark in colour and almost liquid; intestines, the lower part of the ileum showed congestion mainly in the neighbourhood of its mesenteric attachment, Peyer's patches not enlarged; one mesenteric gland was slightly enlarged. The liver and portion of lung teemed with *B. pestis*, while the spleen yielded it in less numbers.

Movements before Attack.—Was constantly employed at the hotel; went out for an hour occasionally only.

Residence, Rats, and connected Cases.—See account of the "Standard Hotel" group in the text.

Case 23 (W).

Summary.—E.F., f., æt. 24, single, barmaid. Residence and employment, "Royal Standard Hotel," City. Observed at residence (T.W.S.), 15th February, 5 p.m.; admitted to Coast Hospital, 9 p.m.; discharged, 27th February; duration of illness, 14 days. Left femoral bubo, small, over saphenous opening, too tender for puncture. Lesions, several flea-bites.

Movements before Attack.—Remained strictly at home.

Attack.—Attacked 14th February, suddenly; at 7 p.m. had a rigor; pain at site of bubo first felt 15th.

Residence, Rats, and connected Cases.—See account of the "Standard Hotel" group in the text.

Case 24 (Y, d).

Summary.—H.W.K., m., æt. 19, single, messenger. Residence, 74, Curtis-road, Balmain; employment, Stewart, Dawson, & Co., jewellers, 412, George-street, corner of Strand Arcade, of which the premises formed a part. Notified by Dr. Campbell, 17th February, 11 a.m.; visited (T.W.S.), 12·30 p.m.; admitted to Coast Hospital, 7 p.m.; died 25th February; duration of illness, 9 days. Right femoral bubo; cultures positive. A few miliary lesions of drainage area.

Movements before Attack.—Had been regularly at work; carried messages to many different places, including some wharves.

Attack.—Attacked suddenly 16th February, 10·30 a.m., shivering, headache, pain in back and neck, delirium at night; 17th, first felt pain in right groin.

Residence.—A two-storey brick house, in terrace, general sanitary state and cleanliness good, connected with sewers; no stables near.

Employment.—A retail jeweller's; large shop and an office on ground floor, workshop and small store over; structural condition, &c., very good; basement concrete under the greater part of the arcade, at entrance to which these premises stood.

Rats.—At residence, no signs. Employment: The caretaker at the arcade had been setting traps on these and other premises for many months, but specimens were not submitted. Between 7th and 11th February 5 *M. decumanus* were submitted by L.A. for the city, and were not infected; in the shop were two or three rat-holes, and rats had a run up a small hand-lift shaft; patient reported that 3 dead rats had been removed from beneath the office floor in the shop about a week before.

Connected Cases.—None.

CASE 25 (Z).

Summary.—H.J., m., æt. 36, widower, barman. Residence and employment, "Royal Standard Hotel." Notified by friends, 18th February; visited (T.W.S.), 11·30 a.m.; admitted to Coast Hospital, 2 p.m.; discharged, 21st March; duration, 33 days. Right femoral bubo; films negative, cultures and inoculation positive. Lesions of drainage area, flea-bites and small healed abrasions.

Movements before Attack.—Constantly at place of employment; usually went for a swim every morning.

Attack.—Attacked suddenly 16th February, 6 a.m., retching and headache; returned to bed; drowsy; some shivering; about 10 a.m. noticed pain, tenderness, and swelling in the right groin.

Residence, Rats, and connected Cases.—See account of the "Standard Hotel" group in the text.

CASE 26 (X, d).

Summary.—G.L., Chinese, m., æt. 47, married, cook. Residence, 11 Mary-street, Surry Hills; employment "Royal Standard Hotel." Notified by the Second Government Medical Officer for Sydney from the Hospital Admission Depôt; visited by temporary Assistant Medical Officer (Dr. C. S. Willis, M.B., D.P.H.), noon; admitted to Coast Hospital, 5 p.m.; died, 21st February; duration, 6 days. Left femoral and inguinal buboes; films and culture positive.

Movements before Attack.—Between home and employment only.

Attack.—Sudden, 15th February afternoon, shivering followed by fever, obliged to cease work at once; pain in groin first noticed about the same time.

Residence.—A cottage in good sanitary state.

Employment, Rats, and connected Cases.—See account of the "Standard Hotel" group in the text.

CASE 26 (AA).

Summary.—C.G., m., æt. 54, widower, labourer. Residence, 3 Harbour-street, City (Darling Harbour); employment, a produce store at 345A Sussex-street; last attendance 20th February, 5 p.m. Notified by friends, 21st February, 2 p.m.; visited (W.G.A.), 2·30 p.m.; admitted to Coast Hospital, 7·30 p.m.; discharged, 21st March; duration, 30 days. Left inguinal bubo; films negative, culture positive. Lesions, a few flea-bites.

Movements before Attack.—Between house and above place of employment only, both in the same neighbourhood.

Attack.—20th February, at 4 p.m. first noticed stiffness and pain in the groin; headache followed, restless night; at examination was walking about his house.

Residence.—A four-roomed brick house, in a terrace, in fair repair and general sanitary state.

Employment.—A small store, consisting of a single room, paved partly with concrete, partly with stone; a small loft containing lumber; shingle roof.

Rats.—Patient found a dead rat while removing the roof 4 or 5 days before attack, but could not remember the date. Between 3rd January and 26th February 1 *M. decumanus*, 95 *M. rattus*, and 1 *M. musculus* collected on these premises had been submitted by the L.A. for the city. Were infected: 1 *M. rattus* 14th January, 1 each 4th, 5th, and 8th February, 3 (and 6 putrid) 11th, 2 on the 12th, 1 on the 14th, and 1 on the 26th; of *M. decumanus*, 1 on 4th February.

Connected Cases.—None.

CASE 28 (BB).

Summary.—F.J.F., m., æt. 45, married, carpenter. Residence, Railway-street, Rockdale; employment, various places (see below). Notified by Dr. McLeod, 23rd February, 4 p.m.; visited (C.S.W.), 6 p.m.; admitted to Coast Hospital, 11 p.m.; discharged, 11th May; duration, 81 days. Left femoral bubo; films and culture positive. Lesions, flea-bites on foot and left leg.

Movements before Attack.—From 14th to 21st February worked by day putting up shelves in a wine-cellar at the "Metropolitan Hotel" (see Case 20; that patient worked as a plumber at this hotel 5th and 6th February, as well as elsewhere; attacked 9th), but also from 6 to 9 p.m. at Hordern's drapery, Pitt-street, on the ground floor near the lift-well. Regularly at home after work.

Attack.—21st February, sudden during afternoon, shivering, frontal headache, weakness, unable to stand; slept well. Early on 22nd first noticed a tender swelling in the left groin.

Residence.—Detached weatherboard cottage of one storey in very good sanitary state; clean; pail closet; no stables near.

Employment.—The "Metropolitan Hotel" was inspected on 15th February, and again on the 25th, by different officers; it was reported to be in excellent condition throughout, including the cellar. Hordern's premises were also found to be in excellent order.

Rats.—At residence, no signs; at the hotel, no signs of infestation. At Hordern's, a dead rat was found under a fixture which was being moved on the evening of the 18th, which was destroyed at once; the patient was present, but did not touch it. However, there were no signs of infestation of these premises; the ground floor opened by a door on a lane at the back; this was open while work was going on, and this rat probably entered by the door and took refuge under the fixture.

Connected Cases.—None (if Case 20 were regarded as connected, it could be so only by locality).

Case 29 (DD).

Summary.—A.P., m., æt. 23, single, butcher's carter. Residence, Telopea-street, Redfern; employment, No. 1, Pitt-street, Circular Quay. Notified by Dr. Binnie, 5th March, 11·30 a.m; visited (R.J.M.), 12·15 p.m.; admitted to Coast Hospital, 6 p.m.; discharged, 11th May; duration, 40 days. Left femoral bubo; films and culture positive. Lesions, a few pin point, healed lesions of doubtful origin.

Movements before Attack.—Between employment and home; on 3rd March (Sunday) went into country and bathed.

Attack.—3rd March, sudden, 9 p.m.; after returning from the country in his usual health ate a good tea, and at 9 o'clock had a rigor, after which there was headache and general pains, sleepless night. 4th, at 1 p.m., T. 105·2°, at night, 105·8°; bubo first noticed during the morning.

Residence.—A three-storey brick house in good sanitary state, clean, connected with sewers; stable near; 107 Bourke street.

Employment.—A butcher's shop, wooden floor, cold storage, and a small yard; connected with sewers; at back, is divided from a fruit shop on George-street by a wooden fence.

Rats.—At residence, no traces; at the stable in Bourke street, used by patient, infestation; no history of dead rats. At employment, the butcher shop was infested, as well as the fruit shop at back on George-street, but knowledge of dead rats was denied. Patient served one coasting vessel at Town's Wharf, foot of Bathurst-street, Darling Harbour, and many public-houses, including one where a plague-rat was taken 15th February. The block in which the shop stood abutted on Circular Quay, whence plague-rats were collected between 21st February and 15th March. Patient had not visited infected premises on the Quay.

Case 30 (CC).

Summary.—G.J.C., m., æt, 27, married, no occupation. Residence, 441 Bourke-street, Surry Hills. Notified by Dr. Brandon, 5th March, 2 p.m.; visited (C.S.W.), 2·30 p.m.; admitted to Coast Hospital, 8 p.m.; discharged, 27th March; duration, 27 days. Left femoral bubo (two glands swollen); films and cultures positive.

Movements before Attack.—Was unemployed; took meals at restaurants in Pitt and in King streets (infected neighbourhoods); was accustomed to walk about the centre of the city, Circular Quay, &c., and once visited a gymnasium in a distant and not infected suburb.

Attack.—1st March, at waking noticed pain and tenderness just below left groin at site of present swelling; this increased on the 2nd, but constitutional symptoms first began, and suddenly, at 8 p.m. on the 3rd, shivering, giddiness, headache, general pains, vomiting, and a restless night.

Residence.—A brick house of 8 rooms in a terrace, occupied as a boarding-house, in fair structural state and good order, connected with sewers; a well-kept stable 2 doors away; the nearest produce store 200 yards away.

Rats.—At residence, infestation with mice admitted and observed, but no trace of present infestation with rats, though 2 or 3 rat-holes were present. No rats were afterwards collected. No evidence of presence of epizoötic plague was got anywhere near the site of these premises.

Connected Cases.—None.

Case 31 (EE, d).

Summary.—S.C.D., f., æt 16, single, confectioner's packer. Residence, 6, Queen-street., Chippendale (City); employment, Dillon and Burrows' confectionery factory, 231–7, Harris-street, Ultimo (City). Suddenly attacked about 1 a.m, 4th March, rigor, for 12 hours was unconscious; 5th, appeared to be better; 6th, vomiting and purging, became comatose, was visited by Dr. Chapple, T. 103·6°; 7th, died at 2 a.m.; duration, 72 hours; Dr. Chapple declined to certify to the cause of death. Notified by Dr. A. A. Palmer from the morgue where he was examining the body under instructions from the Coroner; the Assistant Medical Officer of Government (R.J.M.) was directed to attend the post mortem. Mesenteric, femoral, and inguinal glands enlarged and hæmorrhagic; liver, congested; spleen, large but firm; no pneumonia; multiple hæmorrhages, large and small, over surface of body, and in all internal organs. Films and cultures from liver, spleen, femoral and mesenteric glands, positive.

Movements before Attack.—Between home and work only, save the evening of 2nd March, when she walked as far as Belmore Market. For at least a fortnight before attack had worked full time every day; was carefully looked after by her mother; the forewoman of her workroom lived at her mother's house.

Residence.—A three-roomed brick house in a terrace, very small, fair structural repair, moderately clean, connected with sewers; large stables, fronting another street, at the back; the house and neighbourhood very poor, and much occupied by factories. One or two rat-holes in a floor, no signs of present infestation, and no history of observed rat mortality.

Employment.—A large factory employing about 120 hands, mostly girls; in fairly good structural order, and cleanly kept. The firm have many retail shops, from which empties are returned to the factory for refilling; S.C.D.'s business was to reline empties with paper, lace, &c., for refilling. She had not visited any of the retail shops, two or three of which stood in infected neighbourhoods. It was ascertained that there had been rats about the factory, but at examination no evidence of infestation appeared; half a dozen cats were kept; traps were seen to be set about the place; no hint of recent mortality among them was got.

Connected Cases.—None at the factory; her mother (Case 36) and possibly T.R. (Case 34). See an account of the Chippendale group in the text.

Case 32 (GG).

Summary.—F.D., f., æt. 23, single, dressmaker (?). Residence, 105, William-street (and 167, Bourke-street, immediately before), City; employment, none (or working at home). Notified from Sydney Hospital, 11th March, 10 a.m.; visited (R.J.M.) 10·45 a.m.; admitted to Coast Hospital, 4·45 p.m.; discharged 28th March; duration, 19 days. Left femoral bubo; films and culture negative (11th); film negative, culture and inoculation positive (16th); material abstracted from bubo on both occasions. Lesions of drainage area, a few old flea bites.

Movements before Attack.—Says she received material from one shop only, which never infected. Movements not traceable with any certainty, but dined at two or three different restaurants, none of which were known to be infected.

Attack.—9th March, sudden, 9·30 p.m., rigor and intense headache; 10th evening, P. 130, T. 105°, pain in left groin; 11th, bubo indefinite, fulness in Scarpa's triangle, but individual glands cannot be made out.

Residence and Employment.—A brick house in a terrace, three storeys, clean, good sanitary state, connected with sewers, used as a boarding-house; several stables near by, one large.

Rats.—At residence no signs of infestation.

Connected Cases.—None.

CASE 33 (FF).

Summary.—F.McD., m., æt. 36, single, hawker of tinware in the city. Residence, Model Lodging House, 211, Kent-street, Darling Harbour. Employment, streets. Notified by the Second Government Medical Officer for Sydney (Dr. G. H. Taylor) from the Hospital Admission Depôt, where he had presented himself, 12th March, 11 a.m.; visited (R.J.M.), 11·30 a.m.; admitted to Coast Hospital, 4 p.m.; discharged, 24th April; duration, 48 days. Right femoral bubo; films and culture positive. Lesions, a few flea-bites.

Movements before Attack.—Vague; can only say he has been off work for about a fortnight, at beginning of which he entered on a drinking-bout, and has occasionally not returned to his lodging but has slept in one of the parks.

Attack.—Thinks this occurred about the 7th March, when he had chills and muscular weakness, which he ascribed to drink.

Residence.—Detached brick house, five storeys, clean, general sanitary state good, connected with sewers; stands in the Darling Harbour area (patient's residences here seems to have occurred irregularly).

Rats.—Sign of past infestation only, in holes and runs in retaining walls visible in the yard; infestation of basement with mice; no mortality had been observed.

Connected Cases.—None.

CASE 34 (HH).

Summary.—T.R., m. æt. 37, single, labourer. Address, 9, Milford-street, Chippendale; employment, out of work. Notified by Dr. Cooley, 17th March, 2·20 p.m.; visited (C.S.W.), 3·30 p.m.; admitted to Coast Hospital, 8·15 p.m.; discharged, 3rd April; duration, 19 days. Right inguinal bubo; films and culture positive. Lesions, a small healed abrasion, inner side of tibia.

Movements before Attack.—Visited many places in search of work, among which the foot of Druitt-street, Darling Harbour, where he waited about half an hour on 13th or 14th March, alone call for special remark, the epizoötic having been recognised there a few days after his attack. But he frequented other streets and buildings within the infected area, although he never took his meals away from home.

Attack.—15th March, went to bed in his usual health; 16th, was suddenly attacked 7 a.m., having been aroused by severe pains in head and back; at the same time he noticed a small tender swelling in the right groin.

Residence.—A two-storey brick cottage in a terrace, very clean, fair sanitary state, connected with sewers; two stables not far away, in good order.

Rats.—No signs of infestation, and presence denied; no infestation of the stables.

Connected Cases.—See account of the Chippendale group in the text; but compare place of infection in Case 39, *post*, which this patient visited.

CASE 35 (JJ, d).

Summary.—M L., m., æt. 20, single, cleaner, employed at several public-houses. Residence, 26, St. Mary street, Camperdown; employment, Law's hotel, corner of Pitt and King streets, City. Notified by Dr. Styles, 22nd March, 9·30 a.m.; visited (C.S.W.), 10·30 a.m.; admitted to Coast Hospital, 4·30 p.m.; died, 25th March; duration, 7 days. Left inguinal bubo; films and cultures positive; bloodstained (typical "prune-juice") sputum, negative. Lesions, a few old flea-bites and miliary lesions.

Movements before Attack.—Had been more or less regularly employed as scrubber and bar-cleaner at several public-houses, but his movements were not traced to any house known to be infected; four days before attack he entered on permanent employment at Law's hotel, but was discharged on the day of attack before he had fallen ill; he slept on the third floor, with other employed men.

Attack.—18th March, sudden, at some time during the afternoon; headache and shivering. 19th—Giddy, weak, and pain in left groin; died, 25th. *Post mortem.*—Right lung, normal; left lung, old adhesions of lobes to each other and to pericardial sac, rather deeply injected posteriorly, but contained air; films negative, culture overgrown; mediastinal glands dark chocolate colour, about the size of a bean, films positive, culture overgrown. Liver, apparently normal; gall bladder, many minute hæmorrhages under the peritoneal coat; films prepared from liver, positive; cultures overgrown. The tissues in front of the spine and along the iliac vessels contained extensive hæmorrhages which, on the left side, reached as high as the suprarenal capsule; the chain of glands which extends from the left iliac fossa upwards was completely fused, as also were those on the right side, where, however, no gland below was affected; films prepared from the enlarged glands, positive; cultures, overgrown. Spleen moderately enlarged, dark, firm; films, positive. The intestines appeared to be normal except for slight injection here and there, but the stomach exhibited numerous submucous and subperitoneal hæmorrhages, which were also present elsewhere in the abdomen.

Residence.—Weatherboard detached cottage, clean, fair sanitary state, connected with sewers (W.C. flush-pipe defective); no stable near by.

Employment.—The public-house at which deceased was employed continuously for four days, and where he slept on the three nights which preceded the day of his attack, stood within an infected area, and close to (though across a road from) the locality described under the Bank lane group. A handsome, but rather old, brick building of four storeys, in fairly good order, but having external openings which were not defended by wire netting in accordance with by laws.

Rats.—At residence, no signs; at employment, ample signs of past and of present infestation, but no carcases found, nor any rats trapped.

Connected Cases.—None.

CASE 36

CASE 36 (II).

Summary.—E L.D, f., æt. 46, widow, at home. Lived in the same house with S.C.D. (Case 31) her daughter. Residence, 6, Queen-street, Chippendale. Notified by police, 21st March, 3·30 p.m.; visited (C.S.W.), 4 p.m.; admitted to Coast Hospital, 5 p.m.; discharged, 10th April; duration, 26 days. Right femoral bubo; films and cultures (21st) negative; 23rd, films negative, culture and inoculation positive. Lesions, old flea-bites.

Movements before Attack.—Constantly at home; went only to church five days before attack.

Attack.—16th March, sudden, 3 p.m.; after lifting a heavy box felt pain in the right groin, and found a lump there; shortly afterwards chilliness and weakness; went to bed; vomited. 17th, slight headache. A mild attack.

Residence, Rats, and connected Case.—See Case 31, and account of the Chippendale group in the text.

CASE 37 (KK, d).

Summary.—E.P.R., f., æt. 27, single, house duties. Residence, "Hellespont," Lavender Bay, North Sydney. Notified by Dr. Studdy, 23rd March, 8·30 a.m.; visited (C.S.W.), 10 a.m.; admitted to Coast Hospital, 2·30 p.m.; died, 24th March; duration, 86 hours. Right femoral and left cervical buboes; the first formed a swelling about 3 in. x 2 in. in size, the second about 2½ in. x 2 in., much effusion around both; both painful, both extremely tender; on the right side of the neck was a slightly enlarged and rather tender gland. Films and culture made with contents of the right femoral bubo, positive. Lesions, mark of an old scratch, anterior surface of right leg.

Movements before Attack.—Was preparing for a long voyage, and consequently visited Sydney by North Sydney ferry nearly every day; went to several shops from time to time, and once at least lunched at a restaurant; but her movements, as far as they could be traced, did not take her to any place of known infection except that district at the centre of the city which carried plague-rats here and there, and except the wharf she crossed and sometimes waited at on the Sydney side. Often had to wait a few minutes for a boat, and on 19th (or 20th) March, having diarrhœa, stayed for some time in the women's lavatory, No. 5 jetty, Sydney side.

Attack.—21st March, sudden; having gone to the city feeling well had, at 10 a.m., a rigor, giddiness, a feeling of suffocation; soon afterwards vomiting and diarrhœa set in. First felt pain in the groin and neck 22nd.

Residence.—A 3-storey stone house of 15 rooms, used as a boarding-house; cleanliness good; general sanitary state indifferent. The Assistant Medical Officer of Health, Metropolitan District (Dr. T. W. Sinclair, M.D., D.P.H.), advised the Local Authority to serve notices requiring a trapped gully, provision of permanent ventilation to certain rooms, repair of defective woodwork and paving, &c., &c., and to make the premises as far as possible rat-proof.

Rats.—At "Hellespont," no signs of present infestation, but there were old rat-holes; proprietor said 3 rats had been trapped during the preceding six weeks; many traps set by staff on six nights resulted in capture of 1 *M. rattus*, negative, only; from the next (detached) house, and from two others close by, 4 mice and 2 rats only were got during the same term, all of which were negative. Ferry Wharf, Sydney side, plague-rats had been taken as follows—1 21st February, 1 each 14th and 15th March, from Hart's Marine Café, which was installed on a floor above the extensive wharf itself; and on 16th March 1 carcase in which plague was identified (*M. rattus*) was found behind the wainscoting of the women's lavatory, No. 5 jetty, which was being torn down in course of alterations to effect rat proofing, which were being carried out by the Harbour Commissioners, the owners of the property. This was the lavatory visited by the patient on the 19th (or 20th) March.

Connected Cases.—None.

CASE 38 (LL, d).

Summary.—W.G., m., æt. 68, married, a bricklayer. Residence, Bourke-street, Waterloo (Zetland); employment, *see* Movements before Attack. Notified by Dr. Langton, 28th March, 5 p.m. After death body removed to public mortuary; *post-mortem* examination conducted by the Second Government Medical Officer for Sydney, and attended by temporary Assistant Medical Officer, Dr. C. S. Willis, M B., D.P.H. Septicæmic form; slight secondary glandular enlargement at various points.

Movements before Attack.—From 11th to 16th March, worked at a certain shop in King-street, City, which stands a few doors above Law's hotel (*see* Case 35); 17th (Sunday) and 18th, stayed at home, or looked for work; 19th, began work at R. Reid's, warehouseman, York-street, City; continued till attacked.

Attack.—22nd March, sudden, while at work, towards 5 p.m., vomiting and headache; the vomiting continued till death. 26th, first seen by a medical man, when he had severe headache, T. 102°, pain in right groin. 27th, same symptoms. Was next seen 28th, 4 p.m, immediately after death, when the medical man thought he could feel an enlarged gland in the right groin. *Post mortem.*—Well nourished, punctiform hæmorrhages on inner aspect of thighs, cirrhotic liver, catarrh of the stomach, chronic disease of both kidneys; intestines and spleen normal; submucous hæmorrhages in stomach; a slightly enlarged gland could be felt beneath the right jaw, and another in the right femoral region; they were apparently normal on section, and free from paradenitic effusion; the latter, together with portions of spleen and liver, on preparation of films, cultures, and inoculation, proved positive.

Residence.—A detached brick cottage, one storey, 6 rooms, connected with sewers, in good sanitary state and clean; several stables in the neighbourhood at back.

Employment.—The shop in King-street at which he worked stood near Law's hotel, and in an infected neighbourhood.

Rats.—Residence and neighbourhood, no signs; no infection in the few it was possible to collect. Employment, some traces of past infestation at King street, but no carcases were found, nor was there any history of dead rats; the warehouse in York-street on examination was found to be in excellent order, and to offer very slight signs of presence of rats (hardly of infestation) on one or two floors only; it was said that the whole stock had recently been overhauled, and that no rats were then found.

Connected Cases.—Patient's son (Case 40); see account of the Zetland group in the text.

Case 39 (MM).

Summary.—E.W.E., m., æt. 18, single, labourer. Residence, 59, Woolcott-street, Darlinghurst; employment, Patent Asphaltum Company, foot of Druitt-street, City (Darling Harbour). Notified by Dr. Gleddon, 9th April, 12·30 p.m.; visited (C.S.W.), 1·45 p.m.; admitted to Coast Hospital, 6 p.m.; discharged, 4th June; duration, 59 days. Left femoral bubo; films and culture, positive. Lesions, a minute abrasion on the front of chin.

Movements before Attack.—Was employed for the company at the Exhibition Building, Prince Alfred Park, but on 4th, 5th, and 6th April, in a shed on Druitt-street wharf, mixing materials, and in and out of the store mentioned below.

Attack.—7th April, sudden, 1·30 p.m.; giddiness, headache; first felt pain in the groin at 8 p.m. same day; no sleep. 8th, made a good breakfast and went to work; noticed swelling in the groin at 10 a.m.; was obliged to cease work at mid-day.

Residence.—A boarding-house kept by patient's mother, in fair general state.

Employment.—Outside; but occasionally entered the small office and store for material.

Rats.—At residence, no signs of infestation. At employment, the Exhibition Building presented nothing suspicious; at the office and store, Druitt-street, 1 *M. rattus* was taken on each of the days, 6th and 10th April, in both of which plague was identified, and it was ascertained that several dead rats had been removed from the same premises and destroyed at some time a little earlier; subsequently it turned out that the whole neighbourhood was greatly infested, and plague-rats were identified at several neighbouring places.

Connected Cases.—None.

Case 40 (NN, d).

Summary.—F.D.G., m., æt. 26, single, plumber. Was associated with W.G. (Case 38). Residence, Bourke-street, Waterloo (Zetland); employment, had work on day of attack only, at Union Iron Foundry, George-street, Redfern. Notified by self, 9th April, 9·15 a.m.; examined (C.S.W.), 10·30 a.m.; admitted to Coast Hospital, 4 p.m.; died, 15th April; duration, 7 days. Right femoral bubo; films negative, culture positive; lesions, traces of innumerable fleas.

Movements before Attack.—With his father during illness; attended funeral 30th April; was out of work, and occupied the rest of the time in following up his late father's tracks with a view to contributing to identification of the place of his infection.

Attack.—8th April, sudden, 6 p.m. On rising from the tea table, staggered; felt pain in the right groin, and had to be assisted to bed immediately; rigors, headache, backache, and a sleepless night followed. 9th, no vomiting; wandering mind; about mid-day lapsed into unconciousness. 10th, conscious, but exhibited marked apathy.

Residence.—See Case 38.

Rats.—Search of residence and neighbourhood, including stables near by, between 30th March and 12th April, furnished evidence of no particular infestation, 1 *M. decumanus* and 3 mice having been taken at the residence, and 5 rats and 3 mice from the neighbourhood, all of which were free from infection. Large numbers of traps were set, and careful inquiries made.

Connected Cases.—W.G. (Case 38); see account of the Zetland group in the text.

Case 41 (OO).

Summary.—L.G.M., m., æt. 21, single, clerk. Residence, 19, Frederick-street, Ashfield; employment, Dawbarn & Co., importers, Vickery's Chambers, Pitt street, City. Notified by Dr. Allen, 11th April, 12·30 p.m.; visited (C.S.W.), 2·30 p.m.; admitted to Coast Hospital, 8 p.m.; discharged, 4th June; duration, 55 days. Right femoral bubo; films and culture (11th), negative; 12th, culture of contents of bubo, positive; contents of pustule on calf of leg, positive. Lesions, a few old abrasions; on the calf of the leg there was a pustule of moderate size.

Movements before Attack.—Constantly employed at the importers; visited the Custom House and the Wharfage Office occasionally.

Attack.—9th April, went to bed well; 10th, awoke with a sick headache and pain in the right groin; went to work and continued all day; about 3 p.m. noticed a tender swelling in the groin. The same symptoms continued till examination, 11th April, when his T. was 103·6°, P. 100.

Residence.—Detached brick house, 9 rooms, connected with sewers; good sanitary state; no stables near.

Employment.—Three rooms in a large office building; samples of crockery, glucose, a few tins of grease, &c. General state, satisfactory.

Rats.—At residence, no signs. At employment, patient said he had seen 3 or more dead rats in the store-rooms; and on 9th April another. These were not submitted, as poison had been laid. In one of the rooms was a considerable quantity of rat-dung. Poison had been regularly laid in the basement for two months previously, but none on upper floors, except by patient, as noted above; however, there were few signs of general infestation.

Connected Cases.—None.

Case 42 (PP, d).

Summary.—E.J.O'B., f., æt. 27, married, laundress. Residence, 123, Eveleigh-street, Redfern; employment, Federal Laundry, corner of William and Dowling streets, Darlinghurst, City. Notified by Dr. Langton, 17th April, 4·30 p.m.; visited (C.S.W.) 5·15 p.m.; admitted to Coast Hospital, 10 p.m.; died, 27th May; duration, 76 days. Left femoral bubo; films and culture positive. Lesions, none found.

Movements before Attack.—Constantly employed, and went nowhere but between dwelling and employment.

Attack.—13th April, morning, gradual pain in left groin, headache and loss of appetite; at 7 p.m., rigors, vomiting, and diarrhœa, all of which continued during the three following days. Swelling in the groin was not noticed till pointed out to her (17th). In the course of the illness both eyes were invaded; one was destroyed, the other recovered. Towards the end she suffered from cerebral symptoms, attended with coma, which were markedly relieved by lumbar puncture and withdrawal of about 60 c.c. of cerebro spinal liquid. Films and cultures made with liver, spleen, and pus from the left femoral gland at the 76th day after attack, were all negative.

Residence.—A detached brick house, connected with sewers, in fair sanitary state.

Employment.—Was in very good order; concrete floors.

Rats.—At residence, traces of past infestation, and occupants said the house was infested not later than eight months ago; few rats in neighbourhood, and those trapped were negative. Employment, signs of present, but moderate infestation; a rat-hole within 8 feet of where patient stood at work; 3 rats and 3 mice taken, all negative. A full list of customers was obtained; none of the customers had been infected.

Connected Cases.—None.

CASE 43 (QQ).

Summary.—F.W.P., m., æt. 12, schoolboy. Residence, 368, Sussex-street, Darling Harbour. School, Sussex-street Public School. Notified from Sydney Hospital, where he had applied for admission 16th April; visited (C.S.W.), 16th; admitted to Coast Hospital, 18th, 4 p.m.; discharged, 22nd May; duration, 39 days. Left inguinal bubo, and some enlargement of glands on the right side, as well as in both axillæ; films and culture from bubo (16th) negative; 17th, the same, film negative, culture positive; 19th, from an inflammatory lesion of the left shoulder, culture positive. Lesions, a wound in the left heel (inflicted while bathing) and 3 abrasions of left leg.

Movements before Attack.—Regularly at school; served in the restaurant kept by his parents; ran errands; played on vacant lot near dwelling.

Attack.—14th April, sudden, 7 p.m.; nausea, shivering, headache, giddiness, and a lump in the groin; did not immediately go to bed; 15th, same symptoms, but did not stay in bed; 16th, walked to Sydney Hospital.

Residence.—A brick house, used as a restaurant and dwelling, in fair general state and repair; connected with sewers.

School.—In perfectly good order.

Rats.—At dwelling, signs of present infestation, but no carcases found, nor any rats taken. The school was free from signs, and was rat-proof. The patient said he had seen dead rats (at some time) on a vacant allotment where he played. His residence stood in an infected neighbourhood, from which plague-rats had been taken during two or three earlier months; many wholesale produce stores near by.

Connected Cases.—None.

CASE 44 (RR, d).

Summary.—P.J.O'D., m., æt. 28, single, shop-assistant. Residence, 11, Yelverton-street, St. Peters; employment, McCathie & Co., drapers, 199, Pitt-street, City. Notified by Dr. Chenhall, 11th May, 10·45 a.m.; visited (C.S.W.), 12·45 p.m.; admitted to Coast Hospital, 5·30 p.m.; died, 11th May; duration, 6 days. Right femoral bubo; films and cultures positive.

Movements before Attack.—Irregular; was at work, but drank.

Attack.—5th May, sudden, pain in right groin; 6th, felt weak and giddy, but worked; 7th and 8th, diarrhœa and vomiting, but still worked, supposing his illness to be due to drink; 9th, worked until 3 p.m., when he became unable to stand, &c. Right femoral bubo; films and culture positive.

Residence.—A detached weatherboard cottage in good sanitary state, connected with sewers, and clean; fleas abundant; no stables near.

Employment.—A large building in good order.

Rats.—At dwelling, no signs. At employment, no signs of infestation, but a carcase was found on the ground floor 14th May, which turned out to be plague-infected. A door to a lane at the back on this floor was ill-fitted, so that rats might wander in (compare Case 28; Hordern's drapery was close by McCathie's, and similar circumstances were noted in connection with it).

Connected Cases.—None.

CASE 45 (SS).

Summary.—C.W.S., m., æt. 24, single, labourer. Residence, 118, Young-street, Annandale; employment, Edginton & Co., 207, Sussex-street, produce merchants. Was inoculated in 1900 (Haffkin). Notified by Dr. Fenton, 21st May, 4·10 p.m.; visited (C.S.W.), 5 p.m.; admitted to Coast Hospital, 22nd, mid-day; discharged, 20th June; duration, 33 days. Left femoral bubo; films and cultures positive; lesions, a few healed abrasions (said to be three weeks old) on left shin.

Movements before Attack.—Constantly employed, and hardly went elsewhere than between home and warehouse.

Attack.—19th May, sudden, at 6·50 p.m., chills and frontal headache, but was able to go to church same time; malaise, weakness, and general pains; slept well. 20th—At waking noticed a lump in the left groin, and a smaller one in the left axilla; remained in bed. 21st—Same symptoms. The axillary gland was probably chronically enlarged from other causes.

Residence.—A detached brick house in fair sanitary state, clean, connected with sewers; a stable not far away.

Employment.—A three-storey brick building and a small detached brick store, floors concreted, general state fair.

Rats.—At residence, no signs; at employment, abundant signs of infestation; 9 *M. rattus* and 4 mice trapped there were negative.

Connected Cases.—None.

CASE No. 46 (TT).

Summary.—E.K.W., f., æt. 21, calico-bag maker, single. Residence, 35, Thomas-street, Marrickville; employment, Joyce Brothers & Co., Hay and Lackey streets, Darling Harbour, City; last attendance, 12·30 p.m., 24th December. Notified from Royal Prince Alfred Hospital, 31st December, 11 a.m.; visited (C.S.W.), mid-day; admitted to Coast Hospital, 1st January; discharged, 18th February, 1908; duration, 53 days. Left femoral bubo; films, cultures, and inoculation-test positive. Lesions of drainage area, many flea-bites on leg; there had also been slight injury to the thigh (see below).

Movements before Attack.—Lived at home; attended at her place of employment regularly till mid day, 24th December, when she left to attend a wedding at Petersham; 25th, remained at home; 26th, visited Stanwell Park (a long distance away in the country); 27th, at home.

Attack.—During the afternoon of the 27th received a kick on the left thigh, which was followed by a noticeable feeling of soreness; 28th, headache at waking, vomited during the day, and was slightly delirious; 29th, had medical advice; 30th, noticed some swelling on the thigh in the morning, which was tender, but not painful; was admitted to Prince Alfred Hospital, where a diagnosis of hernia led to incision of the swelling, which was then scraped; in the evening was again slightly delirious.

Residence.—A good brick cottage, semi-detached, in good repair and order; connected with sewers.

Employment.—Brick, two storeys, less than a year old; used as a store for jute bags (imported from India) and as a factory for calico flour-bags, &c. Said to have been built with special reference to exclusion of rats. These premises were in good order.

Rats.—Employment: The premises were in unusually good order, and were not rat infested; but in the course of search, 21 rats were caught, 5 within, 16 in a yard outside, the building, all of which were examined and were free from infection. There were no dead rats. Residence: There were no signs of infestation; no rats were found. It was said that none had ever been seen on the premises, and the occupant of the adjoining (semi-detached) house made a similar statement. Neighbourhood: Patient's house stood about 70 feet from Asprey's produce store, 154, Canterbury-road, Marrickville, where, in the course of search and cleansing of the neighbourhood, and in one only of the three stores used in the business, each of which measured about 50 x 30 feet, 12 rats were killed and 80 rats were found dead; 26 mice were also killed or found dead. Some of these carcases were too putrid for examination; but 44 rats and 24 mice were brought in, of which, 15 of rats were found to be infected with plague, as well as 6 of mice. Plague-infected rodents were also found at Nos. 95 (1 rat), and 103, New Canterbury road (3 rats and 1 mouse), and at 34, West-street, all of which were closely adjacent to Asprey's produce store, though on the other side of the road and in the municipality of Petersham; and, after further search, the infection clearly appeared to be limited to the narrow area thus indicated, of which Asprey's may be regarded as the centre. E.K.W. had not entered Asprey's, but during her return from evening walks had stood habitually, and for some minutes, outside the store, bidding her friends good night, and usually at a point where, as it happened, there was a rat-hole.

Connected Cases.—With the patient, none; but as regards the store, see Case 47.

Case 47 (UU).

Summary.—J.H.K., m., æt. 21, cow-keeper, single. Residence, St. George's parade, Hurstville; employment, the same (he kept 5 cows); last attendance, 30th December, mid-day. Notified by Dr. O'Keefe, 3rd January, mid-day; visited (R.J.M.), 2·30 p.m.; admitted to Coast Hospital, 8 p.m.; discharged, 21st February, 1908; duration, 54 days. Left inguino-femoral bubo, the inguinal mass being the larger; films and culture, from material taken 3rd January from the inguinal mass, negative; culture made from the femoral gland at the Coast Hospital, referred for examination 6th January, positive. Lesions of drainage area, mark, possibly of old flea-bite, on the thigh; there was also an inflamed abrasion on the inner side of right patella, the result of injury received 24th December; microscopical examination, negative.

Movements before Attack.—Was constantly employed in milking his five cows and in distributing the milk to customers; visited the city occasionally, but not Darling Harbour.

Attack.—Sudden, 10 a.m., 29th December; shivering and headache; had risen in his usual health; later in the day abdominal and general pains, and a slightly tender swelling, about as big as a pea, appeared in the left groin; attended to business as usual during morning, lay about all afternoon. 30th, milked his cows and served his customers, but in the course of the day was obliged to take to bed, which he did not afterwards leave; delirious that night and on 31st; better 1st January, and on examination 3rd his condition was unaltered.

Residence.—Brick cottage, detached, 4 rooms, clean, in good order, pail closet; cow bails littered with fodder, which harboured fleas, as experienced by cleansing staff.

Employment.—See residence.

Rats.—It was said that no rats had been seen for about a year past. Neither rats nor mice were discovered during cleansing; there were no signs of infestation of the premises, and no specimens could be found in the neighbourhood; but fodder (namely, 1 bag of chaff, 2 of bran, and 3 of potatoes) was received from Asprey's store (see Case 46) on 24th December, and it was ascertained that these supplies had been taken from the third of Asprey's storerooms, which was that in which plague-infected rats and mice were identified.

Connected Cases.—With the patient, none; but this case was related to Case 46 through Asprey's infected store.

APPENDIX B.

Time-Relation between the onset of constitutional symptoms and observed disease of the gland in which the primary bubo occurred.

There were 47 cases; 7 had no bubo (primary plague pneumonia or septicæmia); in 7 others no sufficient history could be got. In the remaining 33 cases, pain in the gland was the first sign of illness in 8; pain in the gland was observed at the same time as constitutional symptoms in 8; and in 17 the gland was not affected, or was not observed by the patient to be affected, until some hours after constitutional symptoms had manifested themselves.

Pain in gland the first sign (8 cases):—

3. On waking, 6 a.m., observed a small tender swelling in groin; went to work; nausea prevented breakfast; to bed at noon.
4. On ceasing work, 8 p.m., noticed pain and swelling in groin; 9·30 p.m., had a rigor and vomited.
19. At work, during afternoon, noticed pain, and, 24 hours later, swelling in groin; no constitutional symptoms at any time; diagnosis—films and cultures, negative; inoculation, positive.
21. Pain in groin 9 p.m.; slept well; could eat no breakfast; and then the usual acuter symptoms set in.

27.

27. At 4 p.m. first noticed pain in groin, aggravated by movement, headache, and a sleepless night followed.
30. On waking, pain and tenderness in groin; constitutional symptoms began 60 hours later with a sudden rigor.
36. Afternoon, having lifted a heavy box, felt sudden pain in groin, and found a lump; constitutional symptoms began in an hour or two.
44 (d). Felt pain in groin while at work; many hours after became weak and giddy; onset gradual. A drunkard.

Pain in gland and constitutional illness simultaneous (8 cases):—

1. Retired well; awoke at usual time feeling ill, and with pain in groin; went to work, but obliged to cease in an hour or two.
2. Well, and at work all day; felt unusually tired at night and tenderness in groin; next morning too ill to rise.
26 (d). In afternoon sudden rigor, followed by fever; about the same time felt pain in groin.
34. To bed well; undisturbed night; roused at 7 a.m. by severe pains in head and back; at same time found tender swelling in groin.
40 (d). Worked all day; made a hearty tea; on rising from table vertigo and pain in groin; very acute illness began immediately.
41. To bed well; awoke at usual time with sick headache and pain in groin; to work; swelling appeared during afternoon.
42 (d). To bed well; shortly after rising at usual time, headache and pain in groin; at 7 p.m. sudden rigor and other acute symptoms.
43. Well all day; at 7 p.m. sudden attack—rigor, vertigo, headache, nausea, and a lump in groin observed same time.

Constitutional symptoms preceded pain in the gland by hours (17 cases):—

10. Attack sudden, 4 p.m., vertigo, headache, pain in gland first felt 24 hours later.
12. Sudden, 5 a.m.; awoke by rigor, headache, pains in back and abdomen; about 15 hours.
13. At 7 a.m., after waking, headache and general pains; 48 hours.
15. At waking, headache, vomiting; about 12 hours.
17. Gradual attack; general malaise and pain, but continued at work; about 36 hours.
18. Sudden attack; at 4 p.m. a rigor; about 6 hours.
23. Sudden, at 7 p.m. a rigor; about 18 hours.
24 (d). Sudden, at 10·30 p.m. a rigor, headache, general pains; about 24 hours.
25. Sudden, at 6 a.m., after rising, headache and nausea; about 4 hours.
28. Sudden, during afternoon rigor, headache, too weak to stand upright; about 15 hours.
29. Sudden, at 9 p.m. rigor, headache, general pains; 12 hours.
32. Sudden, at 9·30 p.m. rigor and headache, ; about 24 hours.
37 (d). Sudden, at 10 a.m. rigor and vertigo; about 24 hours
39. Sudden, at 1·30 p.m. vertigo and headache; about 7 hours.
45. Sudden, 6·50 p.m. chills and frontal headache; about 12 hours.
46. Awoke with headache, then vomiting, later in day slight delirium; about 48 hours.
47. Sudden, at 10 a.m. rigor, headache, but worked; about 8 hours.

APPENDIX C.

Analysis of the 47 Cases as to traced connection with plague-rats.

A.—Nos. 2 and 27 handled dead rats found on premises which yielded plague-rats.

B.—Nos. 1; 3, 4, 5, 10, 11, 12, 13 (which, with 2, constituted the Bank-lane group), 17; 18, 19, 21, 22 23, 25, 26 (which constituted the "Standard Hotel" group); 20, 24, 28, 37, 39, 41, 44 were employed or dwelt in houses which either yielded plague-rats before or after the date of attack, or yielded dead rats (credibly reported, or found in a state which estopped search for the bacillus) under circumstances which were deemed to warrant the ascription of plague as the cause of death.

C.—Of Nos. 6, 14, 29, 34, 35, 38, 43, 45, 46, it could only be said that they dwelt, or worked in, or visited neighbourhoods in which there was evidence that the epizoötic existed.

D.—In Nos. 30, 31, 32, 33, and 42, the source of infection could not be traced for want of information they included 2 vagrant men, a dressmaker (?), &c. Among them there was also 1 laundress who was ascertained not to have handled clothes which came from any place where a case of plague had occurred; but possible presence of plague-rats at some customer's house could not be excluded, of course.

E.—The remaining 8 cases arose in other ways, apart from plague-rats, or, as regards one or two, did so in all probability. Thus: Nos. 7, 8, and 9 constituted the Campbell-street group; 6 (primary plague pneumonia) has been reckoned under C above; 7 took the disease in the same form from him, 8 took it in septicæmic form from 7; while 9 lived in the same house as 8, in a neighbourhood where nothing suspicious was detected for many weeks afterwards, but may well have contracted his illness (bubonic form) independently, from being engaged in the same trade as 6. Then 15 and 16 constituted the Yule-street group, and were secondary to 5 (noticed under B above); 36 was secondary to 31 (Chippendale group), mentioned under D above; 40 was secondary to 38 (Zetland group), noted under C above; and as regards 15 and 16 it seems certain, as regards 36 and 40 very probable, that the infection was taken by them from the primaries of their respective groups. Lastly, 47 presented no novelty, but so clearly exemplifies communication of the infection by fodder which did not enclose a plague-rat, that it deserves special consideration. Detail of this, and of all the other cases, are fully given in Appendix A.

APPENDIX D.

TABLE showing the Species and Number of Infected Rats, and the Number of Cases in Man, reported during each week of the years 1903–7.

1903.

	Week ending—																																																				
	Jan.					Feb.				March.				April.				May.					June.				July.				Aug.					Sept.				Oct.					Nov.				Dec.				
	3	10	17	24	31	7	14	21	28	7	14	21	28	4	11	18	25	2	9	16	23	30	6	13	20	27	4	11	18	25	1	8	15	22	29	5	12	19	26	3	10	17	24	31	7	14	21	28	5	12	19	26	
M. decumanus	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	8	2	1	..	2	66	3	..	2	1	..	..	..	1	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	86
M. rattus	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	13	..	..	1	..	..	..	9	3	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	26
M. musculus	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	6	10	1	..	1	10	2	12	5	1	..	..	1	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	49
																																																					161
Attacks	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	1	..	..	1	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..

1904.

	Week ending—																																																					
	Jan.					Feb.				March.				April.					May.				June.				July.					Aug.				Sept.				Oct.					Nov.				Dec.					
	2	9	16	23	30	6	13	20	27	5	12	19	26	2	9	16	23	30	7	14	21	28	4	11	18	25	2	9	16	23	30	6	13	20	27	3	10	17	24	1	8	15	22	29	5	12	19	26	3	10	17	24	31	
M. decumanus	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	1	26	..	..	9	1	17	4	3	7	1	1	..	..	1	22	..	..	..	2	1	1	1	..	5	1	3	..	..	1	..	..	..	..	..	..	..	..	108
M. rattus	..	..	..	..	..	..	..	..	..	..	1	..	..	..	..	..	..	1	1	..	..	..	1	6	4	10	36	3	1	..	..	1	1	..	1	..	2	4	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	73
M. musculus	..	..	..	..	..	..	..	..	..	1	2	..	..	..	..	..	..	4	..	..	2	..	2	5	3	4	15	8	3	2	2	1	..	..	..	..	3	1	2	1	..	..	..	..	..	..	..	..	1	..	..	..	..	62
																																																						243
Attacks	..	..	..	..	..	..	..	..	..	..	1	..	..	..	..	1	2	1	..	1	..	1	1	..	..	1	..	..	..	..	..	1	..	..	..	..	2	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..

1905.

	Week ending—																																																				
	Jan.				Feb.				March.				April.					May.				June.				July.					Aug.				Sept.					Oct.				Nov.				Dec.					
	7	14	21	28	4	11	18	25	4	11	18	25	1	8	15	22	29	6	13	20	27	3	10	17	24	1	8	15	22	29	5	12	19	26	2	9	16	23	30	7	14	21	28	4	11	18	25	2	9	16	23	30	
M. decumanus	..	..	2	5	4	1	3	2	8	9	2	1	1	1	1	30	1	1	..	..	..	..	..	..	..	1	..	1	1	..	1	1	1	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	78
M. rattus	..	..	..	..	..	..	..	..	..	..	2	5	8	3	10	3	..	1	..	..	..	..	..	1	..	..	..	..	2	..	..	..	..	..	..	..	2	..	..	..	..	..	..	1	2	1	4	..	..	..	..	..	45
M. musculus	..	..	..	..	..	..	..	..	..	1	3	1	..	4	2	1	..	1	..	..	..	..	..	..	..	..	..	1	1	..	1	..	..	..	..	..	..	..	..	..	..	..	..	..	..	1	..	..	1	..	..	..	18
																																																					141
Attacks	..	..	..	..	..	..	..	..	..	1	..	1	..	4	1	2	2	2	1	2	..	..	..	..	..	..	..	1	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..

1906.

	Week ending—																																																				
	Jan.				Feb.				March.					April.				May.				June.					July.				Aug.				Sept.					Oct.				Nov.				Dec.					
	6	13	20	27	3	10	17	24	3	10	17	24	31	7	14	21	28	5	12	19	26	2	9	16	23	30	7	14	21	28	4	11	18	25	1	8	15	22	29	6	13	20	27	3	10	17	24	1	8	15	22	29	
M. decumanus	..	..	..	..	..	..	..	..	..	2	..	..	..	..	..	..	..	..	..	..	..	..	..	4	..	3	7	2	4	3	4	3	3	1	1	1	3	1	..	1	..	..	..	..	..	..	..	..	..	2	..	1	46
M. rattus	..	..	..	1	..	1	9	4	7	2	3	2	8	14	3	..	..	..	..	..	2	..	..	..	2	1	..	2	2	3	4	3	3	2	5	1	1	1	..	1	1	..	..	..	..	..	1	..	..	..	..	..	89
M. musculus	..	..	..	..	..	..	..	1	3	..	..	..	2	3	..	1	..	..	..	..	..	..	..	..	..	2	..	1	..	..	..	..	..	..	19	5	2	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	39
																																																					174
Attacks	..	..	..	..	..	..	..	..	..	3	4	..	..	..	..	..	..	..	1	..	..	1	..	..	4	2	1	2	..	..	..	..	..	..	..	..	..	..	..	1	..	..	..	..	..	..	..	..	..	..	1	..	..

1907.

	Week ending—																																																				
	Jan.				Feb.				March.				April.					May.				June.				July.					Aug.				Sept.					Oct.				Nov.				Dec.					
	7	14	21	28	4	11	18	25	4	11	18	25	1	8	15	22	29	6	13	20	27	3	10	17	24	1	8	15	22	29	5	12	19	26	2	9	16	23	30	7	14	21	28	4	11	18	25	1	8	15	22	29	
M. decumanus	..	3	..	3	7	4	2	2	2	..	..	4	1	..	..	1	..	..	..	2	1	5	5	3	2	2	1	..	1	..	1	..	..	1	2	1	..	..	..	1	..	..	..	..	..	..	..	..	..	..	..	..	57
M. rattus	..	3	2	..	20	7	8	1	4	4	4	5	..	1	6	7	6	3	4	5	2	1	6	7	2	4	..	..	1	2	1	..	2	11	8	4	2	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	143
M. musculus	..	..	..	..	1	1	1	..	1	..	1	..	3	..	3	1	..	..	..	..	..	2	..	..	..	1	1	..	..	..	..	..	..	..	1	..	..	1	..	..	..	1	..	..	..	..	..	..	..	..	..	..	19
																																																					219
Attacks	1	1	5	7	..	6	6	2	3	2	3	2	..	2	3	..	..	1	..	1	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	2	–

APPENDIX E.

(EXTRACT from the Report of the Board of Health on a Second Outbreak of Plague at Sydney, 1902, dated 31st July, 1903. By J. Ashburton Thompson, M.D., D.P.H., President.)

TWELVE CASES IN WHICH INFECTION WAS NOT TAKEN, IN ALL PROBABILITY, BY CASUAL CONTACT WITH DEPOSITED INFECTION.

262. The infection of plague is communicated to man by inoculation through the skin in the vast majority of cases. The proof has been well stated in the Report of the Plague Commission in India; it is " . . . . that primary buboes practically always develop in connection with lymphatics which originate in the skin . . . . ." The constant preponderance of "inguinal" or "groin" buboes over others, was also shown in the same paper to stand in relation to the larger area of skin which drains through the lymphatic glands of the groin. Analysis of returns, which represented 5,442 cases of bubonic plague, showed that the ratio in which buboes occurred in the lymphatic glands of the head and neck, the axilla, and the groin respectively, was nearly the same as the ratio which the skin-areas draining through the lymphatics of those regions bear to each other.

263. The proportion in which groin buboes are met with always preponderates over that in which the buboes occur in other regions of the body; this was very early observed among Eastern races who habitually go barefoot. Before long, however, the same preponderance was noticed among Europeans (though in small number) who did not go barefoot; but the hint thus given seems to have been overlooked, and (perhaps in consequence) assumed infectiveness of ground-surfaces became a prominent feature in writings on the ætiology of plague. But at Sydney, in 1900, we were able to show that in no less than 73 per cent. of the 286 cases in which buboes were exhibited, the latter were found in the groin, although all the patients referred to were white, clothed in European fashion, and invariably shod during the day (Report, 1900, p. 40). The validity of the banal explanation of the preponderance of groin buboes thus seemed to be rendered more than doubtful.

264. But I had pointed out in the same Report that the infection of plague was received by man, for the most part, within houses, which seems also to have been noticed in India (Plague Commission in India, July, 1901, Report, p. 101). Now, if the infection be usually received by man within houses, the objection raised above to the banal explanation of the preponderance of groin buboes must be revised, for there is a time of day when nearly all people, whites as well as others, go barefoot, namely, when they are going to bed or rising from it; at that time, therefore, infectious material deposited on floors, carpets, &c., by rats (or otherwise) would be more likely to come in contact with the unprotected skin of the feet than with that of any other part of the body. So that, although conjunction between a recent breach of the epithelium and deposited infection in the requisite state of activity cannot often happen, here is the opportunity for it, at all events; and plague was not so frequently contracted by our people in either epidemic but that possibly those persons who exhibited groin buboes might have received the infection in that way. Let us try, then, to ascertain what the fact was: Does the record contain any cases in which infection resulting in groin buboes was, probably, not contracted by casual contact with deposited infection of the unprotected skin of the lower extremities? If it turn out that it does, the hypothesis under examination will be very greatly weakened; must, indeed, be discarded as an explanation of epidemic bubonic plague.

265. Among the 139 cases which constituted the epidemic, there were 106 in which buboes occurred in the groin. But it is necessary to speak more exactly. Our present concern must be with primary buboes, since these alone indicate the region of skin through which the virus entered; and, in order to leave no room for possible confusion between primary buboes and secondary glandular swellings, it is desirable to take into account only those cases in which the groin bubo was solitary. Then the expression "groin bubo" is loose. A bubo in one of the oblique set of inguinal glands indicates infection through the skin of the lower part of the trunk. Buboes in one of the vertical set of femoral glands alone indicate infection through the skin of the feet, or of other part of the lower extremity. An examination intended to discover whether there were buboes betokening infection through the skin of the lower extremity must, therefore, be limited to cases which exhibited *solitary* buboes in one or other gland of the *femoral* chain.

266. The total number of such cases was 60, but the majority are not available for the present purpose. Thus the place at which the infection was taken could not be determined in 16 of them; either the inquiries made failed to reveal any clue to it, or else the evidence for infection at home and at work seemed equally cogent. These 16 must be thrown out, therefore, for they (or some of them) may have been infected at their place of residence, where they were admittedly exposed to the risk ascribed to bare feet which is now under investigation. In 25 other cases it was considered that the patient did receive the infection at his place of residence, so that these, too, must be thrown out for the reason just given. In 3 others the place of employment probably was the place of infection, but the details left room for some slight doubt; these are excluded by way of precaution. Three more were Chinese, concerning whom either information of the required kind could not be got at all, or it was untrustworthy. Lastly, one was a woman whose movements could not be traced. So that 48 of the 60 have to be discarded. There remain 12 patients who had solitary femoral buboes, and who are confidently adjudged to have received the infection away from home (while at work, in all but one case), and, therefore, while fully clothed.

267. Most of the twelve cases have been already referred to at greater or less length; their serial numbers are therefore given, together with a reference to the paragraphs in which the necessary particulars concerning them may be found: 1 (par. 77), 14 (par. 92), 18 (par. 212), 21 (par. 211), 34 (par. 217), 49 (par. 134), 70 (par. 218), 84, 88, 93, 125, 129 (par. 219). The following are details of the four cases which have not previously been described:—

Case 84.—M., æt. 39, a tailor; attacked, March 26, at midday, while at work; discharged, May 24; place of employment, 267 Pitt-street. From under the floor of the room in which the patient worked as a presser nine carcases were removed; many others were found under the floors of adjacent rooms, as well as large quantities of rats' dung, nests, rags, paper, and seeds (from a florist's). Place of residence, Strathfield, a suburb 7 miles away, which has harboured no other case of plague at any time; the house was in very good order, and entirely free from all traces of rats.

Case 88.—M., æt. 55, carpenter; attacked, March 27, morning; discharged, April 26; place of employment, Union S.S. Co.'s wharf, Darling Harbour, which was one of the infected line. Residence, Leichhardt, a suburb about 3 miles away, which had yielded no indigenous cases; the house was in good order, clean, and entirely free from all traces of infestation.

Case 93.—F., æt. 27, sempstress; attacked, April 3; discharged, May 24; place of employment, an upholsterer's, 137 to 141 Castlereagh-street. There were abundant signs of infestation with rats everywhere, but no carcases were found; dead rats had been seen six weeks earlier when, it was alleged, poison had been laid. Residence, Marrickville, a suburb about 4 miles away, which had at no time harboured any other case; the house was in good order, and entirely free from all traces of infestation.

Case 125.—M., æt. 54, carman; attacked, May 11, midday; died, May 16; place of employment, Gray's stables, Elizabeth-street, Waterloo, which were infested with rats, and from which a plague-rat had been taken on April 26; another plague rat was taken at other stables near by on April 21. Residence, 151 Bullanaming street, in fair order; it was said that no rats had been seen there, and there were no traces of infestation; no indigenous case had occurred anywhere near the house, but the further neighbourhood of it was not free from suspicion.

268. Of these patients 8 inhabited houses in neighbourhoods which were distant or even remote from the infected area, and which were at all times free from suspicion of infection with plague (yielded neither indigenous cases, nor plague-rats); and while, on the one hand, 11 of the residences bore no traces whatever of infestation with rats (the twelfth alone having exhibited some slight signs of infestation), on the other hand the places at which the patients were employed (including one who had merely visited Her Majesty's Theatre) were badly infested, and had yielded dead rats in number in ten instances at least.

269. It is certain that these persons all fell into danger at their place of employment, and apparent that they were not infected at home. At their employment they were fully clothed; their lower extremities were protected by boots, socks, or stockings, and trousers or petticoats, while their hands, arms, necks, faces, and in some cases their chests too, no doubt, were uncovered, exposed, and in no way protected from casual contact with deposited infection: and, therefore, they should, *ex hypothesi*, have exhibited cervical or axillary buboes. In fact, however, they none of them did so. They were all of them inoculated in one or other lower extremity—in that very area of skin which, beyond all doubt, was well protected from casual contact with deposited infection.

270. I am unable to imagine any plausible explanation of the inoculation of these 12 persons in the lower extremity, which does not include some means of communication between them and plague rats which is complete in itself, endowed with locomotive powers, attracted to man by instinct, and more likely to reach this than any other part of the body. These requirements betoken an insect, and the insect which best meets them appears to me to be the flea.

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J. ASHBURTON THOMPSON.

APPENDIX F.

Papers on the Defence of India from Plague. Reprinted from the Transactions of the Royal Society of Medicine, Epidemiological Section, 2 December, 1907. Dr. Newsholme, President of the Section, in the Chair.

On the Present Methods of Combating the Plague.

By W. M. Haffkine, C.I.E.

I.

I shall begin my review by briefly enumerating the measures suggested for stamping out the plague or preventing its importation. These measures deal either with man, with inanimate objects, or with the lower animals. The first category of measures comprises:—

(1) Discovery and notification of persons attacked with the disease.
(2) Isolation of the attacked.
(3) Certain precautions with regard to the disposal of the dead.
(4) Segregation of those who have come in contact with the sick or dead.
(5) Institution of cordons round infected areas.
(6) A less drastic and less thorough plan than the last mentioned, viz., placing in quarantine arrivals from infected places, detaining the sick and suspected, and letting the rest free after a time of observation; or
(7) A still less rigorous measure, which is merely to examine travellers, isolate the sick and suspected, and let the others free under a system of surveillance.

The following may, I think, be said in regard to this group of measures:—

The part played by man in the causation of plague seems, on the whole, subordinate to that of other agents. Thus, when the plague first broke out in Bombay, in the summer of 1896, it remained for a considerable time confined to a quarter called Mandvi. The mass of people there are day labourers, working outside their quarter. Though they spent the day in close communion with many other people, cases continued to occur among the Mandvi labourers alone and in their families, and only subsequently and gradually appeared in other quarters. Since that year Bombay has had eleven consecutive outbreaks. Every year the epidemic lasts for some months and becomes relatively quiescent for the rest of the time, but the recrudescence begins approximately in the same locality, and the same events are more or less uniformly repeated.

Subsequent to the appearance of plague in Bombay, a township called Kirkee, near Poona, became infected, and the disease broke out among the native followers of the Royal Artillery. The men and their families lived on a spot somewhat away from the rest of the people, but spent the day at work in the batteries. Throughout the epidemic the batteries remained free from disease, while the followers suffered heavily; and they suffered practically in the same proportion as their womenfolk and children, who did not leave their homes. Similar facts were observed on the Colaba peninsula, in Bombay, among men who, in the daytime, were at work in the Army and Navy Co-operative Stores, and at the Gun Carriage Factory, and spent the night with their families. The other people in the Army and Navy Stores and at the Carriage Factory remained free, but the Colaba men suffered equally with their families.

Further, on many occasions it has been observed that plague first started in a town by attacking persons who had not been away and among whom no history of contact with people from an infected place could be discovered; and, *vice versâ*, in every country invaded by the disease, there are districts, towns, or villages in which, though the people are in constant communication with infected places, and cases of plague are constantly imported into them, the disease gets no footing and the locality remains exempt from invasion.

The proposition illustrated by these facts, viz., that man does not play a predominant part in the conveyance of plague, is supported also by other observations. In 1897 a plague hospital was established in the vast premises of the old Government House at Parel, in Bombay, and a number of patients soon gathered there. In order to minimise the objections to hospital treatment, families were allowed, if they so wished, to accompany their patients, stay at the hospital, and attend on them. The officers in charge soon noticed that when a family took advantage of this permission to dwell in the midst of numerous plague patients, its members were safe from disease; but when they remained in their own home, although the only case of plague had been removed, other cases often followed. In the same way, very rarely has it been seen that any of the permanent attendants in plague hospitals have taken the disease. Pneumonic cases alone have proved dangerous in this respect.

The observations above quoted warrant, I believe, the following propositions, now more or less generally recognised, viz., that (1) plague is what has been termed, in a general sense, a disease of locality; (2) that it is contracted principally at night; and (3) that the part which man plays as direct agent in its propagation is a more or less subordinate one. This being so, the measures taken with regard to man, even when carried to perfection, can influence the propagation of plague only to the same proportionately limited extent. In the vast majority of cases events have conformed with this conclusion, in that precautions taken against the importation or the spread of plague by man have failed to secure the desired end. It must, however, be stated that these precautions can rarely, if ever, be carried to perfection. Their application is fraught with great difficulties, and is often impracticable. This is due to the impossibility of enlisting the self-sacrificing co-operation of individuals, to the first cases being rarely recognised, to the reluctance of those falling ill to deliver themselves into the hands of strangers and officials, to the measures of prevention hurting trade and numerous private interests, and to the consequent wholesale evasion of prescribed rules. The time, therefore, arrives when the measures directed against man are relaxed or dropped, and efforts are chiefly applied to inanimate objects.

II.

This part of the programme seems lighter of accomplishment. The list of measures, within an area infected, comprises, in this case, destruction or disinfection of houses, furniture, clothing, bedding, carriages, goods, warehouses, grain and other stores, garbage, drains and streets. Outside the infected area the measures consist in the refusal to admit carts, trains, and ships with goods from infected places; or in the refusal to admit only certain goods; or in mere inspection of trains, carts, and ships, and some procedure by which these, and the goods they convey, as well as the belongings of travellers, are sought to be rendered harmless. All these measures are intended for the avoidance or destruction of plague germs which may possibly exist in the objects concerned.

Plague bacilli have, however, been very carefully looked for, but so far have not been discovered in the earth, on the walls or floors of houses, or on any inanimate object, unless they were quite obviously and recently soiled by the products of a plague patient. I am not, moreover, aware of a single instance in which the extension of this disease by means of goods of an inanimate nature has been conclusively demonstrated, though linen, clothing, handkerchiefs, and other personal belongings of a sufferer from pneumonic plague, if soiled with his sputum or nasal discharge, must be dangerous for a certain, possibly long, period of time. Further, the microbe of plague is not a resistent organism. From the first it was seen that under ordinary circumstances it was easily killed by disinfectants, and that exceptional conditions are required for that microbe to resist and preserve its vitality. Under these circumstances the following conclusion might seem justifiable: If inanimate objects are important carriers of plague, disinfection should generally be an effective check to its spread, and on this presumption the above measures were devised.

According to numerous observations, however, made by health authorities, a house, its furniture, all the belongings of the inmates, and the inmates themselves may be washed and disinfected repeatedly, and yet cases of plague may occur subsequent to each disinfection, if people are allowed to stay in that house. Though general statements to this effect have been made by earnest observers, I am not aware of a precise demonstration of a case in which disinfection arrested the development of an epidemic of plague.

The above theoretical considerations must be supplemented by the following remarks of a practical nature: The expense and the difficulties of destroying or thoroughly disinfecting houses, goods, and other property over a vast area are very great, and the agency for properly carrying out such measures is not available or is not forthcoming.

The enormous bulk of merchandise conveyed nowadays by rail and ship admits of no process which would answer to elementary requirements of disinfection; and the opposition and hostility of vast numbers of people, whose interests are interfered with by these measures, can only be estimated when the task is actually undertaken.

III.

I come to the measures relating to the lower animals. These are :—

(1) Destruction or keeping away of rats by poisoning, trapping, tar and sulphuric acid mixture, or through the agency of the domestic cat.
(2) Improvements in towns and villages, with a view of reducing or keeping out the rat population, viz., structural alterations of dwellings, warehouses, and grain stores, demolition of insanitary buildings, introduction or improvement of conservancy arrangements, prompt disposal of garbage, periodical inspection of stores, paving and draining of streets, and certain other measures.
(3) Destruction and dispersion of fleas by petroleum or other insecticides.
(4) Fumigation of houses as a temporary protection against rats and fleas.
(5) Obligation on ships from infected regions to anchor away from the shore ; or,
(6) Provision of mechanical arrangements for preventing the landing of rats along mooring cables and gangways ; and
(7) Fumigation of ships arriving with plague patients or plague rats on board.

The measures have, therefore, for their object, and, I believe, rightly so, the rat and the flea, described by Rothschild under the name of *Pulex cheopis ;* but epizoötics of plague break out also among squirrels, tarbagans, guinea pigs, monkeys, mice, kangaroos in Australia, and some other animals, which contribute to keeping the disease alive.

Measures for the destruction of rats were applied in India at the beginning of the epidemic, viz., in 1896, by Professor W. J. Simpson, then Health Officer of Calcutta, and have been carried on also in the subsequent outbreaks in many places. A new impulse has been given to them by the labours of the recent Plague Commission in Bombay. But nowhere, possibly, has the effect of these measures been more carefully gone into than in Sydney, under the direction of Dr. Ashburton Thompson. The campaign against rats and fleas is the most rational and the best founded of all the procedures suggested for stamping out the plague, for outside the human body in animals alone have plague microbes been actually seen so far in nature. It is, however, essential to estimate the extent to which this is a promising direction. Various factors, such as increase of the human population, destruction or planting of forests, occupation of waste lands, building of canals, introduction of new animals and plants, and a variety of other circumstances bring about, in the course of time, important changes in the flora and fauna around us. I might quote, as relatively modern instances, the disappearance of wolves from Great Britain, or the practical extinction of the bison, or of the black rat, from these islands and the continent of Europe, and a few others. These changes have taken place gradually, and in such long periods of time, that the exact causes which have brought them about are unknown.

Up to quite recently it would have been impossible to name a single instance of a result of this kind having been effected in a short time by steps of an administrative character, or even by the resolve of a whole population. From time immemorial man has had to put up with the presence in his proximity of animals and plants interfering with, and devastating, his crops—locusts, field mice, spermophiles, campagnols, phylloxera, mildew, rabbits in Australia, and so on. The power of adaptation and reproduction with which nature has endowed many of these animals and plants generally triumphs over the deliberate efforts of man when the surrounding circumstances are favourable to their multiplication. Still the problem is not wholly impossible.

The recent successful instances, to which I have alluded, are the campaigns against mosquitoes in Ismailia, in Klang and Port Swettenham, in the Panama Canal zone, and in a certain number of other places at which it has been found possible to alter, in a short time, the surrounding conditions so as to render the propagation of these insects impossible. These examples are a grand and splendid lesson to the world, but a lesson which, it must be acknowledged, is, in many cases, difficult, and in others, impossible of imitation.

The observations made by the Chief Medical Officer of New South Wales are of interest in this connection. I have in view his carefully organised campaign against rats in Sydney, with the object of protecting from plague a white population of a high standard of intelligence and education. During that campaign Dr. Ashburton Thompson found that the gross returns of rats and mice caught and destroyed, week by week, were nearly uniform, and that there was thus no evidence that the slaughter produced such an impression on the general horde as would have rendered collection progressively more difficult. The opinion he came to was that extermination of rats in any large area by poisoning and trapping was practically impossible, and that the plan of spreading among them an artificial epizoötic by means of Dr. Danysz's rat virus failed on account of that virus rapidly losing its virulence. Regarding this latter point, one cannot forget that India has now had, in the plague bacillus, eleven years' experience of a most devastating virus for these animals, and as yet there is no sign that this involuntary experiment has rid the country of their presence.

The observations coming from Japan, where determined efforts have been made to destroy rats are as little encouraging. The facts published in June of last year were to the effect that in Tokyo alone 4,800,000 of these animals had been killed, but the slaughter seemed only to have prepared more favourable conditions for the multiplication of the survivors.

Dr. Ashburton Thompson's experience, in regard to facilities given by householders in Sydney for the detection of plague-rats, was identical with that gained in India. He found that the people were reluctant to admit to their premises rat-catchers and other strangers bent on that task, and that the information supplied by the inhabitants, as well as that gathered by the professional men specially appointed for the purpose, was so scant as to be barely sufficient to indicate the presence of infection in a locality, but not to gauge its severity. Though, therefore, the measures against rats, either by extermination or by change in the construction of cities and villages, are a most important item in an anti-plague campaign, the question whether any noticeable impression can be made on the epidemic by these measures within the length of a generation, or even in a longer period, is a matter of great uncertainty. Even the destruction of rats on ships alone, if imposed as a general measure, would cause a dislocation of traffic and an outcry formidable to face. The result is that every day plague is imported, though, fortunately, it does not spread into one part or other of the maritime countries of the world.

IV.

IV.

The above analysis of the facts connected with the problem of stamping out the plague leaves little room for surprise when it is seen that, although in many places reached by the plague, the latter, as I have just mentioned, does not take root and dies out, in others, where it finds a congenial field for its propagation, the attempts at eradicating it prove unavailing. Thus often ends in disappointment what may be termed the *first stage* of the struggle against that disease, namely, the efforts of stamping or keeping it out. This result becomes apparent to the population, who are the sufferers, long before the medical or sanitary authority makes up its mind to acknowledge defeat; and when they first become aware of it the people fly in a stampede in all directions. For, although bare figures of the plague death-rate impress different people differently, there can be no doubt as to a plague actuality being a terrifying event. It takes time to get used and, so to say, reconciled to it. European countries must still have some recollection of their own experience of the matter. The people therefore flee and seek shelter in other towns. But their means of livelihood are left behind in the old place: nowhere is employment and sustenance ready for new and sudden arrivals. After a period of suffering and hardships the fugitives return in search of work to the old place, and resign themselves to the inevitable.

I have referred, however, to the fact that when plague first occurs in a given quarter of a city it remains confined to that quarter for a certain time. There is thus no necessity for going far afield. In the Himalayas and the plains of India the villagers, whenever possible, go out a mile or two from their houses and live under trees or in open fields. Often, however the disease breaks out in the mountains in severe winter, and in the plains during the season of rains. To remain then in the open or in rapidly put-up shelters, with a scanty provision of clothing and bedding, with the difficulties in preparing food, protecting property, caring for and sheltering the small children and the aged, becomes an untold hardship. In towns, on the other hand, unoccupied land is scarce. The people, in fair weather, go into such open spaces and public squares as are available. A water supply, conservancy arrangements, police administration, fire prevention, patrolling of abandoned houses and property, depôts for boxes and bundles, and a number of other arrangements become necessary. With this, the deprivation of ordinary comforts of a settled home is felt so keenly that only families in whose midst cases of plague have already occurred avail themselves of these facilities. The others remain at their homes and furnish material for the continuance of the epidemic. The plan of abandoning the affected locality, for shorter or longer periods, may perhaps be termed a *second stage* in a campaign against the plague.

To whatever extent that plan is feasible, to that extent the effect of it is beneficial. It is the limited range of it and the innumerable complications which it brings in its train that finally lead the administration and the people to resort to what always seemed to me the *ultimate method* of combating the bubonic plague in the areas in which it becomes endemic, viz., that of conferring on the population immunity from the disease by means of an artificial treatment.

V.

I imagine that in this Section of the Royal Society of Medicine it would be out of place to enter into the bacteriological aspect of the anti-plague inoculation, to examine the various views from which the subject might be approached and solved, and the advantages and difficulties of each. For the purposes of the present deliberations it may, perhaps, be sufficient to enumerate the salient points of the matter, as ascertained in India in the last ten years. These are:—

(1) That in a native of that country, who is more susceptible to the disease than Africans, Europeans, and some other races, the inoculation now in force in India reduces the liability to attack to less than one-third of what it is in a non-inoculated Indian.

(2) That in the one-third of cases which still occur, the recovery rate is at least double that in the non-inoculated attacked, the ultimate result being a reduction of the plague mortality by some 85 per cent. of what it is in inoculated Indians.

(3) That in an inoculated European an attack of plague, if it subsequently occurs, has so far always ended in recovery.

(4) That the inoculation is applicable to persons already infected and incubating the plague, and prevents the appearance of symptoms, or else mitigates the attack, a fact which disclosed a basis for the bacterio-therapeutic treatment of disease.

(5) That in natives of India the degree of immunity conferred by this inoculation, though gradually vanishing, seems to last during several outbreaks of plague; and that

(6) In Europeans the effect has not yet been seen to disappear in the space of time, since 1897, that this inoculation has been under study.

I now proceed to matters which concern the epidemiological aspect of the question, viz., the place which experience has indicated should be assigned to this plan of defence in plague-stricken provinces.

His Majesty's letter on the plague, addressed to the Governor-General of India on 13th August last, and Lord Minto's communication to the heads of local governments and administrations, have brought about a renewal of efforts to bring down the plague mortality. Lord Minto's letter points out that many expensive and harrassing operations carried on in the past may be safely abandonod, and expresses the hope that, with the assistance of the people themselves, some distinct advance will now be made towards bringing the ravages of the pestilence under control. Consequently, in most places fresh campaigns have been undertaken and organised in the light of the teaching gained during the past decade.

The Province which has had most of this unhappy experience is the Bombay Presidency, where the disease appeared first, viz., in 1896. The result of this expence may, I think, be gauged from the following official utterances: On 7th October last, the Hon. Mr. Muir Mackenzie, then Acting Governor of that Presidency, in a speech addressed to the Municipal Corporation of Satara, summarised the mutual position of the two pincipal measures on which the Bombay Government have learned to rely in the struggle against the plague. "Evacuation," he said, "is no doubt effective *quantum valeat.* But think of its drawbacks. I doubt if it would have been possible at all during the torrential rains of July and early

August. If managed, think of the miserable discomfort, the risk of chills and fever; and, at its best, what a dislocation of business, what a disturbance of home, what expense, what discomfort, is entailed by evacuation. Evacuation will not cure the stoppage of business, the closing of schools of which you complain. But if inoculation were general none of you need stir—your business would continue, your schools would be full, everything would be as before. I can fancy that in the old days small-pox may have entailed the same miseries as plague does now—fleeing the town, the runaways carrying infection; deserting the home only to catch the disease on daring to re-enter it. Now people, being vaccinated, are hardly disturbed when small-pox breaks out. Let it be the same with plague. Be inoculated at the first sign, and so obviate disturbance of the domestic and educational and business avocations of yourselves and your children."

Sir George Sydenham Clarke took over office as Governor of Bombay a few weeks ago, and on 12th November addressed to the vernacular newspapers a letter of which some telegraphic information has reached this country. He emphasised the heavy responsibility which rested upon the papers of using their influence with the natives to prevent the spread of the scourge. He acknowledged that if the people were unwilling to destroy the rats which were the vehicles of the disease, their feelings must be respected, and he therefore urged that recourse should be had to universal inoculation, which, he stated, was the easiest and most certain method of prevention.

The experience gained in the Punjab (the other great Province of India ravaged by the plague) has been stated in a memorandum which the local government addressed to the Government of India on 30th June, 1902, after five years of the application of various anti-plague measures. According to this statement *segregation of patients and "contacts,"* under the conditions which are essential to the success of that measure, is entirely out of the question, and intercourse between infected and uninfected places is in most cases quite unrestricted; *evacuation* is not a procedure which can be of assistance in checking the extension of plague from one locality to another; *disinfection* cannot be relied upon as a practical measure for the arrest of the epidemic; and there remains only *inoculation* with the plague prophylactic, and its benefits the Government declares, are so generally understood in the Punjab that a large proportion of the population of the infected districts can, without much difficulty, be induced to submit to the operation.

The part of India now exposed more dangerously than all the others is the United Provinces of Agra and Oudh. These provinces have at present, as head of the administration, the able civilian who, in 1898-1900, accompanied and took part in the investigations of the Indian Plague Commission, and had an opportunity of making himself closely acquainted with the working and the results of the various plans tested for combating the plague. In publishing, in the beginning of September last, His Majesty's and the Governor-General's letters on the plague, Sir John Hewett, the Lieutenant-Governor, issued a detailed plan, approved by the Government of India, of organising a special service to carry on inoculation when plague reappeared. The poor, who cannot afford to lose their earnings during the day or two of rest desirable after inoculation, are to be given assistance up to a sum of one rupee per person. Government servants are to have inoculation leave for the necessary period. Railway companies, and other employers of labour, are requested to give similar facilities to their employés.

The resolution issued by the Government on the subject ends by saying that the Lieutenant-Governor "*earnestly appeals to everyone interested in preventing the manhood of the country from being sapped and its vitality destroyed by the scourge of plague, and particularly to the leaders of native society and non-official Europeans who employ labour on a considerable scale, to aid in the endeavour to induce the people to protect themselves by inoculation.*" Subsequent to this resolution the Government of the United Provinces issued orders offering also facilities for those who wish to vacate their houses, and giving detailed and well-thought out directions for the destruction of rats.

Mr. President and Gentlemen, I have endeavoured to place before you the present position of the various measures suggested and tried so far in combating the plague as an epidemic. I have not entered upon the subject of curative treatment of plague, because this would perhaps be outside the scope of this section, and because the result of that treatment leaves much, if not everything, to be desired.

Protection of India from Invasion by Bubonic Plague.

By J. Ashburton Thompson, M.D.

Selection of this topic for discussion by a stranger to India requires justification. I point out, therefore, first, that Australian conditions happened to be so favourable to the epidemiological investigation of plague that data of two classes were there acquired with comparative ease, viz., (*a*) fundamental data which concerned the disease itself and which, consequently, hold good in all countries and under all circumstances; and (*b*) data which concern practical administration, which are liable to modification in different countries by local habits. And then, secondly, I would say that I have no intention of trespassing on the province of the administrator, at least in the details of his work. I propose to speak rather of the statesman, and to point out that which I conceive to be the sole and irrefragible principle which he must impress on administrative staffs, if he would achieve any permanent reduction in the susceptibility to invasion by plague which is so marked a feature of the conditions of life in India.

The fundamental data acquired at Sydney were the following:—

(1) The epidemic spread of plague occurs independently of communication of the infection from the sick; consequently, the infection of plague spreads by means which are external to man, and which are independent of his agency as subject of the disease. The data on which this conclusion is founded were first published in November, 1900.

(2) The plague-rat is harmless to man; it is, nevertheless, the essential cause of epidemics; consequently, some intermediate agent is necessary to convey the infection in efficient form from rat to man. The evidence for this conclusion was first published in July, 1903.

(3) The intermediate agent between rat and man (and between rat and rat) can be no other than the flea foreshadowed by Simond, and, further, actually is the flea. This conclusion also was published in July, 1903, together with the exact observations made in the field from which it was deduced.

The administrative data then acquired were many. They were all referable to the fundamental data; and when it appeared, as it sometimes did, that the conclusions of this class were not in accordance with experience in other parts of the world, it was still found that the differences were apparent and not real, and were easily explicable by the fundamental data already mentioned. For the sake of example, the following instances may be cited. One of them was that transfer of the sick to hospital is a very important curative measure, but is quite without importance as a preventive measure. Another was that there is no such thing as infection of localities or places, although the disease is acquired by resort to certain localities; the explanation is that the local rats are infected, not the places themselves. A third was that clothing never becomes infected with plague, and is never a cause of spread; and it was easily seen that the contrary experience commonly recorded in India was not inconsistent with that conclusion, but was explained by the fundamental datum that the infection is communicated by fleas, which in India very much more commonly infest the people and their houses than in Australia, where such infestation is, for the most part, absent. Observations of the class now referred to may or may not hold good in all respects in changed social conditions; but there was another among them which has not yet been mentioned, and which is certainly of universal applicability. This was that the infection of man was most usually contingent on his being within buildings together with plague-rats; and on considering the fundamental data it became evident that a certain proximity between man and the minute agent of his infection—the flea—must be necessary. Hence it appeared plainly that the exclusion of rats from occupied buildings must be an important item among steps for the prevention of plague, for from the rat alone does the flea derive its power. But more than that, the longer this point was contemplated the clearer it became that the rendering of occupied buildings rat-proof was absolutely the most important item in plague prevention, and even the only one to which the epithet "preventive" could be justly applied. The reasons will be referred to presently; here I would merely note that I advocated this view also first in 1900, and then predicted that its simplicity, and perhaps also its apparent indirectness, would militate against its acceptance by the laity who control the purse, and consequently the means of carrying it out. And it is still the case that attention is concentrated on other measures which, in reality, are merely remedial, or merely palliative, and which are consequently interminable. This, then, is the point to which I wish to draw especial attention; but I must add that I take it to include and to cover destruction of the harbourage which rats find outside, and in the immediate neighbourhood of, buildings. The difficulty of saving the people in a place from attack is proportioned to any difficulty there may be in preventing the access of rats to the buildings occupied by them; but the difficulty of clearing plague away from the place itself is proportioned to any difficulty there may be in removing the harbourage which rats find in the mouths of sewers, in heaps of lumber and rubbish, in loose earth and rubble-fillings, and in dilapidated sheds or the like structures.

It should be noted that the administrator who is faced with an outbreak of plague is perfectly right in relying on immunisation of the people—a possibility laid open to him by the genius of Mr. Haffkine, here present—on evacuation, and on the destruction of rats. These are his only, and fortunately his very effective, means of staying it. But the statesman should be caused to understand that the control of existing epidemics is not a subject to engage his supreme abilities, and that his preoccupation should be how best to diminish the susceptibility to invasion of his country as a whole. The methods just mentioned (I must repeat it) are in fact remedial, not preventive, and consequently they are, as I have already remarked, interminable. If a population be immunised this year it must, if it be reinvaded, be again immunised in a twelvemonth, or a little later; evacuation may have to be repeated even during the same season; and to the killing of rats there is literally no end at all. But every building which is rendered inaccessible to rats may be regarded as a fortress impregnable to that enemy for ever. This, then, indicates the only road the statesman can fitly take; a road, namely, on which every step must be directly towards the goal, and on which there cannot be any backsliding.

The arrest of present outbreaks is a quite different matter from diminution of the liability of the country to suffer them. Removal of the conditions which constitute its susceptibility can alone be justly spoken of as preventive action. And it is, I think, of little use to place scientific truths before the laity unless the expert points out their practical bearing and application at the same time. In order to judge in how far true that is, it is only necessary to ponder the *Gazette Extraordinary* which was published by the Government of India during August of this year. That *Gazette* draws attention to the essential part played by the rat, to the essential agency of the flea, and to the insignificance of deposited infection; but it also expresses the opinion that this knowledge, acquired by it from the remarkably brilliant reports of the Plague Research Committee, will probably not render the task of prevention much easier than it was before. The *Gazette* even mentions the desirability of excluding rats from dwellings, but only to dismiss this method with the remark that it is impossible to expect much improvement in the construction of buildings in the near future. The all important distinction mentioned above between remedial and preventive measures is not perceived.

This pronouncement, then, appears to be rather less far seeing than might reasonably have been expected. For there are many other considerations which must be entertained besides the crude facts which are recited in the *Gazette*. It should be noticed that plague seems to have taken its place among the endemic diseases; and if the uncertain teachings of history seem to offer some prospect of its ultimate extinction by natural process, it should be borne in mind that present circumstances are vastly different from those which formerly obtained, and especially in relation to traffic. To-day plague is a disease to be fought persistently in India, as, I suppose, typhoid fever and cholera are there fought. No speedy exemption is, in my opinion, to be expected.

It must be frankly said that the method of exclusion is practically impossible in the smaller villages, in the larger villages, and in the lesser towns; but this admission is very far indeed from covering the whole case. In the first place, it is precisely in those smaller and more or less circumscribed collections of huts and houses that the palliative or remedial measures are easily successful and, provided the infection be not reintroduced, permanently successful. In the second place, whence do Indian villages derive their infection? Is it not from the great cities on the seaboard and from the larger inland cities which have become secondary distributing centres? And is it, indeed, quite impossible to apply the method of exclusion in them?

I do not doubt that when a broad and comprehensive survey of all the data has been taken, it will be perceived that the exclusion of rats from occupied buildings in cities is the only measure which can permanently diminish the susceptibility of India to plague; and that, as soon as this principle of action has been grasped, resolutions taken by Government will be conceived in the spirit which animated that courtier who, when he was desired to undertake a business which the king himself thought it hardly possible to carry through, replied, "Sire, if it be difficult, it is already done; if it be impossible—it will be done."

Note.—With reference to this paper the following letter has been received:—

Southern Punjab Railway Company, Limited,
70, Cornhill, London, E.C., 7th December, 1907.

Sir,

In reference to the meeting of the Epidemiological Section of your Society on the 3rd instant, my Chairman, Sir Bradford Leslie, desires me to draw attention to a remark made by Dr. Ashburton Thompson that "Every building which was rendered inaccessible to rats might be regarded as a fortress impregnable to that enemy (plague) for ever"; and in confirmation of that view I am to forward the enclosed report of his speech at our last half-yearly meeting, at which he stated the fact that the members of the native staff on the North-Western State Railway, who reside in rat-proof cubicles, with brick walls, brick and cement roofs, and cement floors are virtually immune from plague. Sir Bradford hopes that this corroboration of Dr. Ashburton Thompson's views may be useful to him. I am also to mention that in Bengal, where the climate is humid, water is abundant and daily bathing is the rule, plague does not gain the same foothold as it does in the drier climate of the North-West and the Punjab.

I am, Sir, Your obedient Servant,
URBAN BROUGHTON (Secretary).

Extract from Sir Bradford Leslie's Speech.

"During the half-year under review, *i.e.*, 1st January to 30th June, 1907, the plague has been worse than ever, the total number of deaths in the Punjab being not less than half a million, or at the rate of nearly 25 per 1,000 of the population. This number is greater by 400,000 than for the half-year to 30th June, 1906, and about 150,000 more than for the whole of the year 1905. Even in the town of Bhatinda, with a population of only 13,000, there were over 700 deaths, and in Delhi over 11,000 deaths out of a population of 209,000, or about 1 in 20 of the population of each place. Unfortunately, it is generally young people in the first vigour of their youth who are struck down. It is remarkable that the North-Western State Railway employés, who number some 55,000 in the Punjab, where they are housed in staff quarters on railway land, with proper regard to sanitation on European principles, had a death-rate of only 1 per 1,000 per annum, including their families; but in places like Lahore, where, for want of space, the railway employés have to live in the native towns, they do not escape the prevailing disease. It is hoped that His Majesty's gracious letter to India on this subject will stimulate investigation and remedial measures."

DISCUSSION.

The President (Dr. Newsholme), in introducing the authors, reminded the Fellows that the meeting was a special one, called in the first place to do honour to two distinguished confrères; and, secondly, to enable Fellows to learn that which they were so competent to teach. He did not think it possible to imagine a greater contrast in the conditions under which plague might prevail than those in India and those in New South Wales. In one instance was a community fully invaded by the disease, in which difference of race, religion, and civilisation held good, and in which measures which might be successful under the conditions of western civilisation would obviously not be completely available. On the other hand, there was a city like Sydney, well-governed, inhabited by a people who were our own blood-relations, and who recognised the importance of sanitation. Those were the two classes of experience which would be placed before the meeting. In one case it was a relatively easy task to keep the plague under control; in the other it was extremely difficult, especially when, as was the case in India, the disease was already rampant when Mr. Haffkine's genius discovered the remedy which had done so much to minimise the prevalence of the disease and to diminish its fatality amongst those who were attacked by it. On that point there was no difference of opinion among those who had had the opportunity of investigating Mr. Haffkine's remedy for plague. One could realise the immense importance, in a country like India, of having such a remedy which could be adopted when ordinary measures of sanitary control and prevention of importation were, to a very large extent, inapplicable. Those present would congratulate Mr. Haffkine on the fact that he would shortly be returning to India to resume his most important work there. That work had been interrupted for a short time through no fault of his, and they congratulated not only Mr. Haffkine, but still more, India, in that it was again to have the benefit of his invaluable services. He had said that, in Sydney, the task of keeping plague out and preventing its spread was a simpler one than in India; but that by no means detracted from the merit of Dr. Ashburton Thompson's pioneer work on plague in Sydney. Those who had read his masterly reports on plague in Sydney must have felt with what care he investigated every detail concerned, and got to the bottom of every outbreak. They were masterly expositions of epidemiological research.

The following observations were contributed by Major Arnim, I.M.S.: It is true that in the earlier stages of an outbreak—when only a few foci of the disease are known to exist—the use of the full epidemiological armament of notification, isolation, disinfection, segregation, &c., is justifiable; and it is expedient to isolate the patient, disinfect his house and belongings, segregate contacts, &c. With regard to the isolation of the plague patient, it is a question whether his removal to a suitably situated isolation hospital, where he is inaccessible to the *uninfected* rat-flea, is not quite as justifiable as is the measure—now adopted in the prophylaxis of malaria—of isolating a malarial patient from the possible attacks of the *uninfected* mosquito. In the earlier stages of a plague outbreak the above measures are, I think, justifiable. But in instances where the disease has assumed a widespread epidemic or pandemic form, these measures are useless, and their application to a locality causes unnecessary inconvenience and suffering. We are, under these circumstances, thrown back upon the three lines of defence which experience and observation have shown to be of most value. I refer to (*a*) preventive inoculation; (*b*) the removal of the community from the rat-infected area; (*c*) the removal of the rat from the infected or threatened area. It is upon this latter measure that I would ask permission to say a few words, and upon an aspect of this subject to which I believe sufficient importance is not yet attached by plague administrators. The value of inoculation has already been referred to, as have also the advantages of evacuation and the great difficulties often attending it; the task of efficient rat destruction by poisoning, trapping, &c., has been declared to be "practically impossible"; but no great stress has been laid upon systematising what might be termed "rat prevention." I refer to the taking of simple but rigorous and systematic measures to prevent the congregation of rats in large numbers in areas threatened with plague. Rats are natural scavengers, and will congregate where there is waste food, garbage, or rubbish lying about. Where debris of this nature does not exist, the rat will not be found—he vanishes. As an instance: I have in mind a large Indian town of over 100,000 population where plague appeared in 1897. Among my other duties connected with the outbreak I was asked to take special charge—with regard to preventive measures—of the Sudder Bazaar, an area which was situated between the military and European lines and the native city in which the disease had appeared. The first step taken in dealing with this area was to make a minute inspection of the houses. In the basement of each house was found a mass of garbage—filth and rubbish of all kinds. Only to the person who is well acquainted with the interior economy of the native house of India is known the heterogeneous mass of rubbish which is allowed to collect in the basements of the premises. In this instance I ascertained that the reason of these unusually large collections of rubbish was mainly due to defective scavenging, and to punishment being feared if the debris was thrown on to the streets. Hence, all house-sweepings, organic debris, old rags, and, in many instances, absolute filth had been allowed for long periods to accumulate in the house basements. I enlisted the assistance of the householders, and had all the basements of the houses cleaned. The rubbish was removed by sweepers into the roadways in front of the houses and there burnt (for days afterwards the Sudder Bazaar was enveloped in smoke); and the basements were then lime-washed, and latrine receptacles renewed and tar-painted. Plague never appeared in this area in true epidemic form, and the place came to be considered as protected from the disease, which was virulent in its vicinity, and some people attempted to smuggle their sick into the area, believing that they would become cured there. I believe that the removal of the rubbish from the houses, and the systematic cleaning up of this area, had discouraged the rats from infesting it to an abnormal degree, with a result that the incidence of disease in the area was much diminished. It is a matter of common observance that on occupying a house which has for some time been tenantless, the place may be absolutely free from rats and mice. After a time, when food has been left lying about in the larder, or on shelves and tables, rats and mice will appear. So it is with houses in India, and more especially so on account of the prevalence of the unpaved and uncemented basements which exist in nearly all the native houses. I merely speak these few words in the hope that general cleanliness of houses, and more especially of their basements, will occupy a more prominent place in future plague policy. People should be encouraged to keep the basements of their houses scrupulously clean, and should be advised not to allow any refuse, waste food, old rags, or filth, or debris of any kind to collect in their areas; and should be further urged to keep their cooked food and uncooked food supplies in such a manner as to prevent rats having access to them. The greatest boon to India would be if the natives—both Mohammedans and Hindoos—could be induced to regard the rat as the Mohammedan regards the pig, and that any food or matter with which the rat had come into contact became regarded as spoiled and tainted.

Professor W. J. Simpson said he had had the advantage of reading Dr. Ashburton Thompson's paper, as well as Professor Haffkine's, so that he was in a better position than otherwise he would have been to take part in the discussion. He had read both papers with an interest which was increased by the fact that the authors presented the subject from different points of view. On one point he thought most would agree with both authors, namely, that the rat plague played a predominant rôle in the causation of human plague. Perhaps Dr. Thompson had given expression to that opinion too broadly, for it had to be qualified by the fact that pneumonia-plague, at least, might have nothing to do with rat-plague. Unanimity on the relationship of rat-plague to human plague marked a distinct stage in the etiological and preventive aspects of the disease, because in the one case it allowed of further investigations being undertaken without any disturbing uncertainty on a very fundamental question, and because in the other case it indicated the direction in which plague measures should be taken, and which Professor Haffkine had called a rational method for dealing with plague, which could be done without waiting for the complete solution of the problem which it was hoped might be reached by continuous and systematic investigation. Dr. Thompson had stated his views shortly and clearly, and no one could complain of any hesitancies. On reading the paper one would come to the conclusion that the whole problem of plague was settled, because Dr. Thompson held that the plague-rat was harmless to man, and that the intermediate agent between the rat and man and between rat and rat could be no other than the flea, and actually was the flea. Those views were based on his own observations and on the results of experiments by the Plague Commission. They, however, erred in an inclination to generalise too much on insufficient data. In illustration of that he quoted an interesting case in the last report issued by Dr. Thompson, that of a man and wife simultaneously attacked with plague. Each of them had flea-bites on the drainage area of the bubo. There were no rats at the residence, but at the man's workshop another workman had killed two sick rats and picked up two dead rats, and there were found, in the process of cleaning, the carcases of ten rats in an advanced state of decomposition. Plague bacilli were not found in them, nor in a number of rats trapped in adjoining and neighbouring premises. The husband's illness was attributed to flea-bites received at the workshop, and as the causation of the wife's simultaneous attack could not be put down to fleas in the house, it was stated "it would seem that the only possible source of infection must have been a flea imported to her house by her husband from the factory, which she herself had not visited." The evidence was not very strong in favour of that assumption, but it was about the strongest which had appeared in any of the former reports. Hitherto, with most people, it had been merely a working hypothesis, supported by a few experiments, that the flea was an active agent in the propagation of plague. That hypothesis had been converted into a certainty by the experiments of the Indian Plague Commission, which had established the fact that the flea was perhaps the most important agent in the dissemination of epizoötic plague. The interpretation which he put upon those experiments was that the flea was an active agent in the causation of epizoötic of plague in the rat, but it did not appear to justify the claim that the flea was the only agent, or the setting aside of the successful feeding experiments of Kitasata, Yersin, and Wilne in Hongkong, the German and Austrian Commissions in Bombay, and those of Klein in this country. There was always a tendency to run the newest view to the extreme. It took time to obtain the due perspective, and he thought that was the case in this instance. At one time it was inoculation, then it was feeding, now it was the flea. Might it not be that they were all responsible? When one found that rats were susceptible to plague by inoculation, by feeding, and by the laying of plague materials in the nostrils of rats, it was difficult to see why the flea should be selected as the only agent. That was still more the case with regard to plague being always conveyed by the flea from the rat to man. The experiments on that point had been but few. They were his own in Hongkong and the few made by the Indian Plague Commission, but the most that could be said with reference to them was that the rat-flea could infect the monkey, and probably man, and they confirmed what was pointed out by Simond and Hankin in regard to that point. But that was a very different matter from the flea being the only agent. Monkeys were very susceptible to feeding with plague-infected food; why should man be not similarly infected? In Hongkong, where many *post-mortems* were made, the pathological evidence was not small that many cases of plague, apart from tonsillar and cervical cases, were produced by feeding. If the *post-mortem* records of the cases in the early days of the Bombay plague were examined, there would also be found evidence of lesions of the stomach, intestines, and mesenteric glands in considerable number. Possibly it was because Dr. Thompson's experience had been mostly with bubonic cases that he held such strong views on the flea theory. Septicæmic cases were not common in Sydney, and it was a strange but interesting fact that bubonic cases of plague appeared for the first time only during the sixth outbreak of plague last year. It might be asked what happened to the flea that produced that phenomenon. He thought that under the circumstances all the fundamental facts were not to be found at present in Australia, and that the last word, however desirable it was, had not been said on the causation of plague.

Mr. Haffkine's paper dealt less with causes than with methods of prevention. That gentleman accepted all the theories, for they were a matter of indifference to him, and it was only essential for him to compare the failure of other methods with the successes which attended the use of the prophylactic, and to show the superiority of that method over others. If he, Professor Simpson, had to deal with the epidemic in India, and had the choice of adopting only Dr. Thompson's method or that of Professor Haffkine, he would have no hesitation in selecting Professor Haffkine's. Dr. Thompson's remedy, which was also Dr. Creighton's, was a good one, and must appeal to sanitarians, for he supposed that in rebuilding the houses there would be included the provision of good light and ventilation, as well as protection from rats. But it failed in the very important particular that it would probably be useful for the protection of India when the next epidemic invaded that country, say in about a couple of hundred years. The statesman, therefore, who adopted Dr. Thompson's policy might be hailed by the remote descendants of the present generation as a benefactor, but he would scarcely be considered to be carrying out what were ordinarily understood as the functions of a statesman, namely, the solving as far as possible of the problems which arose for the benefit of the present generation and those of the near future. He would further state that even if the rebuilding of India could be carried out in ten years, much of its value would be discounted by the customs of the people. Wherever the Indian lived he liked to have his grain with him, which was natural, just as our own housewives like to have their stores in the house. Plague had been known to attack Indians and leave Europeans free, even in cantonment houses which were well built, and where Indians had at times been permitted to reside. The reasons for the invasion of plague into such well-built and sanitary houses had been that the rats of the locality had been attracted into the particular houses by the granaries established there. Plague has also occurred in gaols, which were generally well built, and it had occurred even in some of the newly-built houses erected by the Bombay Improvement Trust. Last year he visited several of those houses with Dr. Turner, the Health Officer. The rats gained access to the houses by creeping up the rain-water pipes and by other means. There could be no doubt that the most immediate and probably the most easily applied preventive, if the confidence of the people were obtained, was inoculation. It could be applied on a small or on a large scale. In Calcutta, whenever a case of small-pox occurred in a house, the inmates of the house and those of the immediate surroundings were, as far as possible, vaccinated. A similar arrangement might be introduced in regard to plague. Simultaneously an organisation should be formed to popularise and carry on inoculations on a large scale in every infected centre. Probably that would be done when Mr. Haffkine returned to India. The weak point in the inoculations, however, was that the protective power did not last very long, and so long as that defect lasted he feared it would always be difficult to induce people to be inoculated every two or three years, except under the stress of a great mortality. It was for that reason that, although inoculation must be recognised as a powerful weapon in the hands of the sanitarian, it could not be depended on alone; a general fighting an enemy did not depend only on his infantry. It was impossible to close one's eyes to the fact that the primary cause was still existent, and as we thought we knew what the primary cause was—which was not the case when we depended on vaccination against small-pox—it appeared necessary to go further and attack the cause or causes as known to us at present. If the infected rat were got rid of, it did not much matter whether man got the disease from the fleas of rats, from infected foods, or from other agents. In the chain of causation the rat was the more important factor to deal with, and he believed that just as Professor Haffkine had been a benefactor to India by the discovery of the plague prophylactic, he would add still more to that country's indebtedness to him if he could discover a more potent microbe than Danysz's bacillus which would destroy the rat and yet be harmless to human beings and other animals. It should not be supposed that plague was endemic or epidemic in every village and town in India, and he believed that the policy of a free and unrestricted trade in plague distribution from infected centres to healthy localities had contributed to the present deplorable conditions. Measures should therefore be taken to prevent this, either on the passport system adopted in the Madras Presidency or by others which would readily appeal to the trained sanitarian. With regard to disinfection and its supposed inutility on the grounds stated by the Commission, that a contaminated flea lost its infection in a few days, and that plague bacilli could not be found in the soil, he wished to add his dissent to that which had already been expressed by Dr. Turner. In those particular experiments it might be so, but he thought it was generally agreed that tetanus bacilli lived in the soil, but how often were they looked for and could not be found? To search in an infected room for the bacillus of plague was like looking for the proverbial needle in the haystack. Against those experiments of the Commission were other experiments. How was one to account for the fact that, according to Gladdin, the bacillus would live for over three months on food such as raw and coagulated albumen, turnips, potatoes, plums, apples, cucumbers, &c., or those of Batazoff, in which the organs of plague animals dried in vacuum for thirty-eight days at the temperature of the room, infected animals after that period, and of those of Gotschlich, who found the bacillus alive and virulent in eight and a half months' old cultures which were dried and mouldy. Again, clothes would have to be disinfected, even if it was the flea which only carried the infection, as he did not suppose that the clothes would be opened up and fleas searched for. Even then they would have to be killed, and he took it that destruction by disinfectant was easier than catching them and destroying them, as the Chinese women did, by cracking them between the teeth. For carrying out any of the measures a properly qualified sanitary service was needed in India. It was because of the absence of that service that most of the failures arose. It was also the secret of the failure of the great inoculation campaign in the Punjab, where villagers, instead of properly qualified men and women, were employed to open the battle and assist in the technique of the inoculations. The Japanese had recently four towns infected, and the organisation they brought to bear on the prevention of plague was 1,200 medical men. They had 513 deaths altogether. In the Punjab there were during the epidemic of this year over 600,000 deaths, and there were in 1906 only ten Europeans and thirty-eight native medical men employed to combat the disease. If the whole 750 medical men in the Indian Medical Service had been released of their duties all over India, which was an impossibility, and had been drafted into that one province, it would not have equalled the organisation of the Japanese.

Dr. J. F. Payne said all the Fellows would be very grateful to Mr. Haffkine and Dr. Thompson for their exceedingly valuable papers, more especially as the authors had not remained immersed in the atmosphere of scientific doubt, but had each put their views in the clearest and most definite manner. He did not believe the views of those two gentlemen were opposed, and he did not see why the plans respectively advocated should not be carried on simultaneously. With such a combination of forces it might be hoped that a much more serious impression might be made on the great invasion of plague than by adopting any one separately. With regard to rats, it was clear that in all the places which had been investigated of late during the great pandemic of plague, rats had been found largely concerned with the distribution of the disease from one place to another and with its local production. But it had not yet been proved that that was the only source of plague, and for several reasons. Every epidemic of plague recently described in the great pandemic had been carried from one part of the earth's surface—namely, from the mountain country of Yunnan, in the south of China. There it had been endemic no one knew how long. In that country particularly epidemics of plague were connected with the deaths of animals living underground. That plague was carried from Yunnan to the coast, and thence to the south of China and on to Hongkong, and from there distributed over the world. But plague had come from there just as cinchona plants, wherever found, came originally from America. The relation of plague to the death of rats had been before the profession for more than fifty years. Not to mention some rather obscure earlier reports, in 1853, Surgeon-General Francis, of the Indian Medical Service, published a report in which he described how the mountaineers of Kuma, on the slopes of the Himalayas, had turned out of their houses on account of plague when they observed dead rats. That had been known to people who had investigated plague in other parts of the world. For a long time the chief places for the investigation of plague were Mesopotamia, Baghdah, Kurdistan, and Persia, but not in the Far East. Those investigators in Persia and Baghdad were very careful and conscientious people, and included Surgeon-Major Colville and a French physician, Dr. Tholozan. Surgeon-Major Colville said they had never seen anything of the kind observed in the Himalayas. Though his own personal experience was very small, he wished to relate one incident. When he went out, in 1879, to investigate the plague on the Lower Volga, in the province of Astrakhan, especially at the village of Vetlianka, which had become historic, the epidemic was practically over, and they only saw a few patients who had recovered. It was being much talked about, but never a word was said about rats. His own impression was that the common European rat did not exist in that country at all. The great naturalist, Pallas, who travelled there in the last century, said it did not exist there then. While waiting in the village with nothing to do, it was their custom to walk about and into the neighbouring country, where they saw many burrows made by a little mouse. He noticed many skeletons of these animals, and on asking about them was told that a number of the mice had died during the winter. He believed it was the *Mus montanus.* Since then it had occurred to him that this might have had some connection with the epidemic. The plague had in many other places not been connected with rats. At present the Yunnan plague was being carried into Egypt and other old seats of plague, and it remained to be seen what would happen. Therefore he did not think there was evidence that the connection of plague with rats was a universal law. He had no doubt that the evidence in regard to fleas was correct, but it was not necessary to suppose that clothing never transmitted the plague. People who were just dead might have clothing which might have contained fleas. In the celebrated village of Derbyshire, which had plague communicated from London, it arose from the clothes being put before the fire to dry, and it was well known that the flea could jump. He thought that they were not entitled to say that the cure or prevention of an epidemic disease like that by inoculation had no effect in checking its endemic prevalence. With regard to malaria, for instance, though it was strictly local, if there were a population saturated with quinine mosquitoes could not get hold of the plasmodium and carry it about, and this had an effect in stopping malaria. Quinine not only cured the individual patient, but diminished the prevalence of the disease. Therefore in India, if at one time there were hundreds of thousands having plague, and if that number were greatly reduced by inoculation, the chances were that the dissemination of the bacillus, the parasitic circle by which the parasite was carried from one animal to another, from man to the lower animals, and from the lower animals back to man, would be checked; it was scarcely fair, then, to say that inoculation had only a temporary effect.

Colonel Macpherson said a good deal had been said about the effect of inoculation in preventing plague, also the effect of getting rid of rats from dwellings. It had also been said that the flea was the conveyor of plague from rats to man. But he wished to ask Mr. Haffkine and Dr. Thompson whether they had made many experiments as to the manner of preventing the flea from biting man. One knew that there were many insecticides used by people in common life for the purpose of preventing themselves being bitten by fleas; and if the flea was the transmitter of plague it would surely be a simple process for each individual in the community to protect himself by using a definite insecticide.

Dr. Sandwith said that nobody who had read Dr. Thompson's reports could do anything but echo the President's praise of them. Those reports first converted him to the rat theory, and later to the rat-flea theory. He was certain the rat theory was correct, and he believed the other was right also; but he agreed with Professor Simpson that it was not fleas alone which caused plague. In his paper Mr. Haffkine said: "Though general statements to this effect have been made by earnest observers, I am not aware of a precise and convincing demonstration by experiment of a case in which disinfection arrested the development of an epidemic of plague." He (Dr. Sandwith) was very much in favour of disinfection in preventing the spread of plague, because in Egypt since 1899, though the officials of the Public Health Department had not stamped out plague they had kept it under, and this had been achieved without any of the special means recommended in the papers read to-night. Disinfection had been carried out in two ways; first, by filling up the rat-holes and destroying the rats, by removing rubbish, whitewashing and cleaning buildings, isolating patients, and watching "contacts." That was found to be insufficient. A second measure which seemed to be of some importance was washing the floors and walls of rooms with corrosive sublimate, 1 in 1,000. That was found to be expensive, and the natives complained when they came back to their homes that their chickens had died; so for several reasons it was temporarily given up. But in the villages and houses where corrosive sublimate was used in addition to the ordinary disinfection process, plague had never yet returned, though it had often returned in places where this extra measure had not been adopted. A reference had also been made to the domestic cat, and he wished to refer to that because Major Buchanan, in India, had proposed that the plague could be minimised by increasing the number of domestic cats. But the cat is susceptible to plague, not quite so much as the rat, but still to a dangerous extent. He asked Mr. Haffkine why he said that the native of India was more susceptible to the disease than the African and European. He (Dr. Sandwith) did not know any reason for considering the African and the Indian to be on very different levels of susceptibility. It had been said that Dr. Ashburton Thompson omitted reference to pneumonic-plague, but plague had so recently reached New South Wales that the authorities were fortunate in having stamped it out before pneumonic cases had occurred. Pneumonic-plague was a term adopted in 1896 from Bombay, although previous epidemics had been known as "cough-illness." Pneumonic-plague in Egypt had sometimes caused eleven deaths in a house of eleven people. He did not suppose that the flea was responsible for that pneumonic-plague, except indirectly. Any case of pneumonic-plague may become septicæmic, and secondary pneumonia sets in, and then the patient disseminating his sputum can cause primary pneumonic-plague. He hoped Dr. Thompson meant that not only the laity—who should be instructed by medical men, and only by them—but also the medical men should work, not only between seasons of prevalence as the various outbreaks were called, but all the time, as some plague was present every month in endemic countries, and the fight should be continued until the disease had been absent among humans for at least a year.

Dr. Fremantle said there were many suggestions of definite theoretical values which, on being put to the test, were often found wanting in regard to plague, and he would be glad to hear whether one or two in particular had been tried. In regard to houses, he would like to hear whether weight had been given to the method of building which he saw at Rangoon, where, building being carried on on land largely reclaimed from the Irrawaddy, houses were built on piles, and in such a way, thanks to the general foresight of the sanitary department, that there was a clear foot of daylight between the ground and the floor of the house. It seemed also desirable to separate adjacent roofs in the same way as in this country parapets were provided to prevent the spread of fire. In such a form there would be a really rat-proof house. Whether that was the reason that Rangoon had never taken plague he did not know, but there was the fact, and he did not think it was simply due to a thoroughly carried out quarantine system. There might be some similar reason in the construction of their houses for the immunity of Japan from plague, notwithstanding that there was a good deal of intercourse between China and Japan. At any rate one saw the reverse system of house-building in Hongkong coincident with an annual recurrence of plague. There the rats not only infected the houses, but actually burrowed again into the brittle bricks which were used within a few days of the most thorough disinfection. Unless the approach of rats was cut off, it would be of little use to rebuild the houses. It would surely be well to start experimental schemes in the centre of plague-infected areas, in villages, for instance, in the Bombay Presidency and in the Punjab; that could be done without difficulty, and different schemes could be tried in different batches of houses. It had been said that the rat should be exterminated, and those who, like Dr. Thompson, had tried it in earnest said it could not be done. He (Dr. Fremantle) thought they were, in that matter, going beyond their province as medical men, and were not giving due weight to those essentially qualified to investigate it. They were dealing with a problem outside their profession, and required for its solution the assistance of a naturalist like the late Frank Buckland or the present secretary of the Zoological Society, Dr. Chalmers Mitchell, who would understand the different methods of exterminating one pest by another set of animals. In India very much was to be done by means of education, and he hoped the Government would take up the question of education in the schools, so that the community might be instructed in the general methods employed in combating the plague. A great question was how to induce the people to accept inoculation. In the Punjab the plague officers were welcomed by the headmen of the villages and those who wish to stand well with the Government, and they and their families were inoculated, but unless plague was actually prevalent the number of inoculations would be limited to 120 or less. It might be well to adopt some method of stimulating them through a monetary payment to the headmen of the villages. Finally, he urged that the question was an Imperial one, and therefore there should be definite correlation between the various Boards and Departments interested in the matter throughout the Empire, rather than action on isolated lines.

Dr. C. J. Martin, F.R.S., said he had listened to both papers with great interest, but it was too late to discuss them at all fully. In Dr. Haffkine's paper there was so little matter that was controversial that he felt he must agree with him when, at the end of his paper, he pointed out that at the present time the most hopeful method for India was the palliative. As to the method in which the substance was given, all must have been struck by the extreme modesty with which the facts were presented. Even if it had been presented in a different way there would have been little cause for complaint. He listened to Dr. Thompson's paper with some emotion, because that gentleman was his earliest preceptor into the mysteries of epidemiology. A good many years ago Dr. Thompson asked him to read over a paper on the "Epidemiology of Leprosy," perhaps on the principle at the bottom of trying a substance on a dog before giving it to a human being. He did not understand much about the subject then, but the paper was crowned with a prize as being the best paper on the "Epidemiology of Leprosy" in any country, so probably the experiment was justified. But he could not allow to pass without comment the part where Dr. Thompson said that India should be rebuilt. It would be difficult to rebuild India, with 300,000,000 people, most of whom had not got houses, as we understood the term. He did not know whether the concluding passage of the paper, relating to the courtier of the king, came from the "Arabian Nights," but it might well have done so. He hoped that king had a firm treasurer, because ultimately everything of the kind became a financial matter. Every unit of the population of India had but a small amount of money. In the finances of the country there might be a surplus of a million or so, but if the whole wealth were divided among the people they would still be very poor. It would be impossible to carry out in such a country measures which were successful in a city like Sydney, with its wealthy population. In conclusion, he wished to pay a tribute to the extraordinary epidemiological acumen by which Dr. Ashburton Thompson was led, quite early in the study of plague, to realise first of all the essential dependence of human epidemics upon rat epizoötics ; and, secondly, to the fact that there must be some intermediary between the rat and the human being in order that a rat-plague might cause a human epidemic.

Dr. Chalmers (Medical Officer of Health, Glasgow) said he had scarcely any reason for interposing in the discussion, because one of the papers was on the prevention of plague in India and the other was devoted to a method of combating plague which was not applicable to this country, and which he doubted the suitability of to India. He said that because in this country for two or three generations we had had a similar experience in regard to small-pox, we had not yet succeeded in convincing people that they could, by vaccination, protect themselves against small-pox. So he was not hopeful that, without a panic in India—which no one wished to see—it would be possible to press inoculation to the extent necessary to stamp out the disease, because in twelve months it might be necessary to do it all over again. The whole genius of the country was against the rebuilding of houses rat-free ; it had taken two generations of medical officers to persuade the authorities that even in the matter of ordinary diseases the rebuilding of houses was necessary. And all knew how slowly rehousing went on, even in slum areas of England and Scotland, and one asked whether it was likely to be more successful in the case of plague. His own knowledge of plague was acquired in this country, and the experience of anyone here was that there was first of all a genial tolerance, as of a momentary vagary on the part of the medical officer ; and secondly, there was a discussion as to whether this or that should be done, no credit being given for acting as a reasonable being. All regarded the rat-flea theory as having some association with plague. The work of the flea had been demonstrated beyond cavil in the last report from India. In his first experience of plague in 1900 he talked the matter over with Sir Thomas Fraser, and told him he was worried about the rats, as people told him they were kept awake at night by them. Sir Thomas's reply to that was that unless the rats were seen and came into the open there was nothing to fear, and that that was the experience in India. But that was not the experience in Glasgow. They endeavoured to catch the rats, but none of those caught were found to have plague, except one, which was caught in the ordinary run. Several times rats were caught which had plague, but no one near was suffering from the disease. The most recent experience was in a particular building, where there was a sanitary officer on duty most of the day, police constables occasionally, a caretaker, and a Sunday-school class muster. In that building thirty-one rats died, and by the merest chance the thirty-first was found to have plague. Hankin, two or three years ago, suggested that while one might accept the rat as being a continuer of plague, possibly something made the flea at one time capable of carrying the disease and another time incapable of doing so. That was only part of the larger question as to why we were having plague in the last ten years. If any explanation of that fact were forthcoming, any light as to means of overcoming it might be clearer. He did not know whether the killing of rats would do any permanent good, for there was a natural law that the birth-rate of any species was directly related to its death-rate, and possibly the result of a vigorous campaign against rats might be an increase in their birth-rate. In India it had been said there were now as many rats as ever, notwithstanding the enormous destruction of them during the last ten years. With regard to disinfection there were two views to keep in mind. The plague organism must be assumed to live outside the body, but only to a limited extent. If chemical methods of disinfection were used there still remained the flea. He had used formalin, but air-breathing animals would not be affected by formalin. It was known, from the work done in India, that a flea fed on a septicæmic rat would communicate the disease for a definite series of days if it were fed daily. How long would a flea not fed in the usual way live? If the flea was capable of transferring the infection from one animal to another, and if a rat could live without feeding for that period, how far might it travel? He asked because of a certain association with rags in his own experience. Recently there was some cause for suspecting that rags might have caused a case of plague. And in order to catch the rat flea guinea-pigs were put in cages in the rag-store. Human fleas were caught in the rag-store, but no human fleas were caught in the house. They put human fleas into test-tubes, and allowed them to have plenty of air, and until the ninth day those fleas remained active without any food at all. He did not know whether the rat-flea would live longer. With regard to Mr. Haffkine's proposal as to the disposal of the dead he (Dr. Chalmers) did not appreciate that. He had been anxious over the dead who died from plague in Glasgow, and wanted to have cremation, but failed. He therefore arranged for the burial under restricted conditions. But even in a body dead twenty-four hours it was very difficult to recover the organism in a virulent condition. It had already undergone considerable degeneration. There were many things in the character of the organism which seemed to determine its virulence.

Mr. Haffkine, in reply, said that owing to the lateness of the hour he would deal only with one or two points, viz., with those on which he had been asked for some information. In reply to Colonel Macpherson he said that Dr. Turner, Health Officer of Bombay, had given attention to a plan of protecting houses from fleas by means of naphtha or petroleum products. Certain of his observations appeared encouraging, and the plan was being tried further in Bombay, Poona, and elsewhere. Attention had also been directed in India to the possibility of avoiding flea bites by oiling the skin with mustard or other oils used by Indians of certain castes. The matter called for close and persevering investigation. Dr. Sandwith had put to him one or two somewhat difficult questions. The first concerned his view as to the difference in the susceptibility to plague of Indians, Europeans, and Africans. Somalis, Sidi-boys, Kaffirs, and Europeans of all classes when attacked with plague recovered comparatively easily, whereas in Indians the proportion of deaths to cases was often as high as 70 per cent. ; in the other communities it rarely went above 35. From the information kindly given him by Dr. Sandwith, and that which appeared in publications, he concluded that the latter figures held good approximately also for the Arabs in Egypt, at any rate in the case of the endemic form of the disease. The fact that among Europeans inoculated against plague fatal attacks were yet unknown, while in Indians they were observed in a certain proportion of cases, and that in the former the immunity conferred by the inoculation was apparently of a longer duration, seemed to him to stand in relation to the same differences between the two races. If Africans, Arabs, and Europeans showed these advantages in ridding themselves of the plague infection when the attack was already on them, he surmised that they had the same advantages when struggling with the virus in the incubation stage and endeavouring to ward off the first onset of the attack. Dr. Sandwith had, further, referred to his statements regarding disinfection, and quoted the villages in Egypt where the treatment of native huts with corrosive sublimate had been seen to permanently free them of plague. He attached great weight to Dr. Sandwith's observations, and must plead ignorance of the facts he referred to. As far as his present experience went, he had not known cases pointing to a relation between disinfection and the cessation of an outbreak of plague. He was open to conviction, and held the opposite opinion entitled to attentive and earnest consideration.

Dr. Ashburton Thompson said, in reply, that it was too late to discuss all the interesting points which had been raised, but he would touch on some of them. Drs. Payne, Simpson, and Chalmers had all declined to admit that the rat was the sole cause of epidemic plague. He would first ask what other cause had reasonably—nay, he would even say had plausibly—been suggested? However, their hesitation rested in reality on negative evidence, namely, the non-discovery of plague-rats in certain places. But he had again and again remarked on the difficulty there most often was in detecting disease of the rats on any area; and, while the older observers had no means of identifying the cause of death in any carcases they may have encountered, in the accounts of more recent epidemics there was no evidence at all that an adequate search for plague-rats had been made. Dr. Chalmers went even further. He was able to say that at Glasgow he had found no plague-rats in close association with cases; where cases were found there were no plague-rats, and where plague rats were found there were no cases. He welcomed that statement, for it represented his own early experiences. But he had had a more extensive and a more prolonged opportunity than had fallen to Dr. Chalmers, who, if he had had the chance, would have found ultimately that his observation, correct though it was, was incomplete; and he would unavoidably have come at last to the conclusion, already formally expressed by the speaker, that the plague rat was harmless to man save in the presence of an intermediary agent. Professor Simpson had fallen into one or two inadvertencies which it seemed important to point out, just as in the course of lectures recently delivered by him he had asserted that plague had occurred at Sydney in a mild form—an assertion which was not founded on any fact. Professor Simpson, in the course of his remarks, had quoted a case in which the speaker had appealed to the agency of the flea to explain the observed facts, as though the facts had been adduced to establish the agency of the flea; and he had said that this case was about the strongest evidence which the speaker had at any time adduced in favour of the active agency of the flea. But, in fact, the epidemiological evidence for the reality and the essential character of the agency of the flea was of a totally different kind, and had been set forth four years ago, in the speaker's second report, not in the sixth report from which Professor Simpson had quoted. However, that was generally known to those specially interested in plague; and after having remarked that his suggested remedy was not the same as Dr. Creighton's, as Professor Simpson had alleged (for Dr. Creighton thought that the infection of plague was taken with the breath from the ground-air, and not from rats, nor from any source other than that), he would conclude by saying that as he was unable to share Professor Simpson's views on the pathology of plague, there could not be any common basis of discussion between them. Dr. C. J. Martin's kindly criticism contained the only direct reply to his suggestion which had been made, and for well-known reasons it was entitled to the highest consideration. Dr. Martin had strongly asserted that the rebuilding of India had been demanded, and was evidently impossible. He would remind Dr. Martin of the maxim "*Divide et impera.*" That which appeared impossible when viewed as a whole, assumed a different aspect when it was regarded in detail; and he thought that if the fact that the infection was present in the concrete form presented by the animal body, in particular places, and was thence by mechanical agencies transported afar, there to form new local centres of infection and distribution, were more carefully considered and dwelt upon, it would be seen on reflection that his recommendation was far from being chimerical.

APPENDIX G.

REPORT to Section V of the XIVth International Congress of Hygiene and Demography on the mode of Spread and the Prevention of Plague in Australia.—Berlin, 1907.

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PREFACE.

THE way in which plague spreads is one and the same everywhere. If it has seemed to be not identical in all countries, I think observed differences casual and dependent on local habits. Man plays no part in it. Plague epizoötic on the rat is the essential factor in diffusion of this disease and in production of its epidemic form. Yet the plague-rat by itself is impotent. Its infection cannot be commonly communicated to man except with help of an intermediary. The efficient intermediary is the flea, which infests the rat and occasionally attacks man after its proper host has died. Prevention of epidemic plague consequently lies in habitually maintaining a distance between the rat and man, for measures directed against the flea can have scope only in special circumstances. The requisite separation between man and rat will be better secured by improving the construction of buildings than by attempts to exterminate the rat.

These conclusions were deduced solely from epidemiological observations made under favourable circumstances at Sydney in 1900 and 1902; they have since constituted the principles on which all efforts towards the control of plague in New South Wales have been directed. They were first published in July, 1903, and they have now been confirmed by the experience of five subsequent years. The data then collected reveal—as far as they go—the natural history of plague. Deductions from them form a complement to results obtained under experimental conditions in the laboratory, and may be used to control theoretical applications of the latter to explain field-experience.

REPORT.

1. Australia escaped invasion by plague until after the disease had appeared at the capital of New Caledonia (1), an island which lies a thousand miles from Sydney, in the fourth quarter of 1899. The infection entered by way of Sydney, where attack in the first case occurred on 19th January, 1900. But the people had been threatened from the time plague appeared at Hongkong (2, 3), and their danger was apparently increased when it began to prevail at Bombay (4), and at Mauritius (5); for with all these ports Sydney has communication in the way of trade, which in the case of the two former places is regular and frequent. In short, it had seemed extremely probable that Sydney would be infected sooner or later long before its infection actually took place. Hence it had been my business to study the details concerning plague which were published from time to time during the six years 1894-1899, with a view to fixing upon some plan by which initial action might be guided as soon as the disease should appear.

2. Decision on the available material was difficult, although all that was required was some plausible hypothesis of epidemic plague to be held tentatively, and entirely subject to the results of experience. There was no lack of quantity, and on the clinical side it was nearly complete; but on the epidemiological side it was undigested, inexact, contradictory, and incomplete. Especially the fundamental question as to the share taken by the sick in diffusing the infection remained unanswered; in the general opinion it was predominant, and even to-day its extent, its nature, and consequently the conditions by which it is limited, remain uncertain for the majority. Two papers had been published, however, which, (and which alone) seemed to me to constitute valuable contributions to the epidemiology of plague. E. H. Hankin (6) had shown reason for thinking that the degree in which plague prevailed stood in relation to the accessibility of dwellings to rats, and in no relation at all to the poverty, filth, and bad ventilation in which people who inhabit dilapidated houses usually live. At the same date P. L. Simond (7), in a brilliant and penetrative work, expounded his reasons for thinking that plague usually resulted from inoculation, that inoculation was commonly effected by a parasite, and that the parasite ordinarily concerned was the flea. As to matters of fact these two papers were suggestive rather than conclusive, and for that reason, perhaps, had not the influence on the course of subsequent investigation to which, as it has turned out, they were entitled. However, on comparing them with the contradictory records already referred to, it appeared to me that they went far towards reconciling the latter. I determined, therefore, to guide initial action by them.

3. The defects in the evidence available to Hankin and to Simond, which had led the former to suggest that fragmentation of the carcases of plague-rats by ants might so disseminate the infection as to contribute importantly to epidemicity of the disease, resulted from the conditions under which they had been compelled to work. Consideration showed it to be unlikely that good evidence on many important points would or could be gathered until an outbreak should occur among a civilised and homogeneous people, under circumstances in which particulars concerning the infection of a majority of the individuals attacked could be learned with approximate accuracy, and in which the events of the epidemic as a whole could be discovered with completeness. The requisite opportunity seems first to have occurred at Sydney, where the population of about half a million was wholly white, wholly civilised, spoke the mother-tongue of the observers, and had been well-trained in obedience to the peremptory discipline of the health authority in the course of several epidemics of small-pox which had been summarily suppressed during the preceding twenty years. The first outbreak (8) lasted from January to August, 1900, and consisted in 303 cases. A plague-free interval of fifteen months ensued, terminated by commencement of a second outbreak (9) in November, 1901, which lasted till June, 1902, and which consisted in 139 cases. It will be noticed that the numbers of cases were on the one hand large enough to avoid observational error, and on the other not so large as to cause embarrassment.

4. The question which most urgently required answer concerned the share taken by the sick in diffusing the infection, and on that point attention was concentrated during 1900. The evidence was as follows:—The requisite particulars were learned in 289 of the 303 cases. The 289 patients occupied 276 dwellings which for the most part were widely separated from each other. Of these dwellings 266 harboured but a single case apiece, although 37 patients had died at home at or before notification, and although a large majority of the remainder had lain at home three days or more before their cases came to knowledge. In 1902 these observations were completely corroborated. Thus, 124 of the 139 patients occupied separate dwellings, and 115 of these dwellings harboured but a single case apiece; 14 of the patients had died before notification, and as in the previous year most of the remainder had remained at home for three days or more before they were notified. Still, some houses did furnish multiple cases in both years, namely, ten houses in the first, and nine in the second outbreak. These exceptions afford the means of trying the rule of non-communication of infection from the sick which is indicated by the experience in general; they must, therefore, be examined in detail.

5. The ten households of 1900 yielded thirteen secondary cases. They could be divided into three groups. Group A comprised three households, each of which furnished a single secondary case. In them the hours of attack were so nearly simultaneous that communication of the infection between the primary and the secondary cases was excluded by the shortness of the interval. Group B also comprised three households, each of which yielded a single secondary case. A precisely contrary condition excluded the possibility of communication between the members of these pairs; it consisted in the length of the interval. Not merely did this exceed twenty-two days in all of them, but in it the primary patient had been separated from the rest of the family, the latter had been removed from home, and the house with its contents had been cleansed; further, in only one instance had the primary patient left hospital and rejoined the family before the secondary case occurred.

6. In Group C were four households in which the time-relations of the successive cases were such that communication of the infection from the primary patients to the remainder was possible. All of the cases, both primary and secondary, were bubonic. One of these houses yielded four secondary cases. The primary case was removed within twelve hours of attack; the rest of the household remained at home for two days, and were then removed. On the third day after isolation of the primary case two, and on the fifth day two more of them, fell ill. They were all under medical observation, and the hours of attack were seen to be very close in each of the two pairs; the first pair was isolated from the second pair at the first sign of illness. In two other households of this group which yielded one secondary case apiece, the intervals

between attack of primaries and secondaries were three and four days; the components of both pairs fell ill at home before notification. In the fourth household the secondary case occurred in a child who had occupied the same bed with her mother during the latter's fatal illness, which had lasted eight days, and who was attacked twenty-four hours before her mother died. Interpretation of the examples in this group is facilitated by comparison with the circumstances of Groups A and B. These show that the time-relation is of secondary importance. Exposure of both or all of the infected members of each household to the same conditions appears to have been the determining factor, and the circumstances of Group C admit this explanation. When further comparison is instituted with the teaching of the 266 households in which no secondary case occurred, then, I think, the question of causation of the secondary cases in Group C is answered. Regarding them as a whole, it seems very improbable that the cause could have been communication with the primary patient; but it is possible, or even likely, that the last case may have been so caused.

7. The apparent exceptions turn out, then, to corroborate and reinforce the more common experience. It is unnecessary, therefore, to examine the nine exceptions met with among the 124 households of 1902 at the same length, since they furnished fifteen secondary cases which presented quite similar characters; but the features exhibited by one group were so striking that they must be detailed. This Group D consisted of seven cases which occurred among a large number of people who lived at an hotel. Of these seven persons, five were attacked at the hotel; but before the first of them had fallen ill the other two had removed to two different dwellings at a long distance from the hotel and from each other, neither of which could be suspected of infectiveness. They had left the hotel in perfectly good health, and had not again communicated with it, nor with its remaining inhabitants, nor with each other; yet they fell ill at their new abodes —the one two days, the other three days after having arrived there. No cases occurred in the two households they joined.

8. At the same time two other observations which bear on the question of communication from the sick were made. Total want of connection between successive cases was most often established with certainty; and the interval between them was often longer, and even much longer, than the incubation period of the disease.

9. All this evidence thus checked appears to me decisive, and to warrant a general rule, namely: The *epidemic* spread of plague occurs independently of communication of the infection from the sick. This general rule furnishes an indispensable foundation for all further investigation, and it carries with it a corollary which can be used as a touchstone of truth in many doubtful conjunctions, namely: The infection of plague spreads by means which are external to man, and independent of his agency as subject of the disease.

10. I do not know what caused the contrary opinion to be held in former times, for the grounds of judgment seem to me—in as far as I am acquainted with them—to be seriously defective. If, however, question concerning the causes of epidemicity be separated from question concerning possible communicability, then the latter must be answered in the affirmative. Primary plague-pneumonia furnishes a conspicuous exception to the general rule, and the reason of the old opinion may well have lain principally with it, though it be now relatively uncommon, easily managed, and far from giving rise invariably to series of cases. The other forms also cannot be denied a possible importance in those days which, under much improved social conditions, they no longer possess; and, indeed, present-day experience among half-civilised and poverty-stricken peoples rather seems to warrant this speculation, at least if imperfectly recorded experiences be liberally interpreted. In short, it appears to me that the dictum (10) "every person who suffers from plague is capable of communicating the disease, and the danger is greater or less according to the form the disease takes" is justified, but in a general sense. It is useful as a warning. It omits to recognise the fact that realisation of the epidemic-danger depends not merely on the form of the disease, but chiefly on surrounding circumstances. If humanity and economy are to be regarded as desirable features in measures for the prevention of plague the general rule must be recognised, and the reasons why exceptions to it sometimes occur, the natural limits to their possible effects if in any case they happen to be overlooked, and the conditions, if any there be, under which alone they could acquire national importance, must be defined.

11. The foregoing analysis of the groups of associated cases shows that the primary patient was not the point around which they centred. It suggests that they were linked by the influence of some external condition to which all their members had been alike exposed. This hint accrued in the course of an inquiry which sought to discover merely whether the sick, as presumed centres of infection, in any way influenced the healthy who were in contact with them; consequently it was concerned merely with dwellings where cases had been harboured without any reference to the manner in which those cases had arisen. The suggested association of the infection with place was examined in a different way. If place were the determining factor, then groups should be discoverable which were composed of persons who were independent of each other in every respect save recourse to the same place. Such groups were found without difficulty. To mention those only which were indisputably established in 1900 by exhaustive investigations into the personal habits and circumstances of each of their component members, analysis of the records for that year resulted in recognition of seventeen such groups. They consisted of from two to four persons in each, and they comprised a total of forty-three persons who occupied forty-three separate dwellings. These dwellings were almost always distant from each other, and for the most part stood in neighbourhoods which at no time fell under suspicion of infectiveness. The sole distinguishable bond between the components of each group consisted in their resort during the day to the same workplace, to which they did not return, or where they did not remain (as the case might be), after the onset of illness. Thus the evidence that the infection was not diffused by the sick met its counterpart in this clear evidence that infection could be taken by resort to places where no sick person had ever lain. Other such groups were noted in 1902 and in subsequent years.

12. Consequently it then fell to be inquired in what the infectiveness of locality consisted. A possible explanation was at hand. From antiquity it had been observed that rats sometimes died in numbers in places where man died of plague; and after 1894, when it was first made possible to identify the disease in the rat with the disease in man (11) this coincidence was more regularly recorded. It was even observed occasionally that the rats suffered first. But whether the rat infected man, or man the rat, and whether both did not acquire the disease independently of each other from some source which was common to both, remained undetermined; and yet, as time went on, the often-observed coincidence came to be generally spoken of in terms of cause and effect as between rat and man, though still no definite warrant had been derived from experience, and though it had not infrequently been reported that epidemics had occurred where no evidence of presence of an epizoötic had been gathered. And while, on the one hand, the meaning of this coincidence could never be deduced from repeated examples of it in whatsoever number they might accumulate, on the other a too exclusive application of bacteriological possibilities to explain the data gathered in the field tended to divert attention from it even as a phenomenon which required explanation, and allowed a preponderating share in the causation of epidemics and epizoötics alike to be ascribed to imagined factors. In the meantime this clue had been taken in hand at Sydney, and an attempt had been made to follow it through the maze which apparently contradictory observations had gradually woven. It broke. The general coincidence on areas was once more recorded, but the precise and more intimate connection between rat and man which would have revealed opportunity, at least, for direct communication of the infection could not be made out.

13. Had this result been purely negative it might well have been tentatively ascribed to merely incidental circumstances which, it might have been supposed, would be eliminated as experience was gained. But positive evidence also accrued which seemed to throw doubt on the efficiency of the rat as the essential cause of epidemicity. Thus in 1902 plague was bacteriologically identified in rats found on forty inhabited or frequented premises, and yet these findings were accompanied by plague in man only four times. Again, when plague in the rat (whether identified or inferred) and plague in man did coincide on the same premises, much the most often but one person suffered out of several or even many who seemed to have been equally exposed, all of whom might safely be regarded as having been equally susceptible. Again, it was observed that the handling of dead plague-rats was but rarely followed by infection; there were indeed apparent instances to the contrary, but it almost always (not quite) turned out that the handling had taken place much too recently or too remotely to have been connected with the cause of attack. Besides, even at that date it had become clear from common laboratory experience that dead plague-rats are practically harmless provided their juices are not inoculated into those who dissect them. Two other observations to similar effect were made. When plague-rats and cases did exist on the same premises it was most often possible to exclude contact, and even close neighbourhood, between them; and rarely the closest scrutiny failed to detect either rats or traces of infestation with them on premises where circumstances compelled the conclusion that the infection had been received. Contact with any live rat was found to be an extremely uncommon occurrence, and no case of rat-bite (which if the rat happened to be infected would almost certainly communicate the disease) was heard of. All of these data have not equal weight; nevertheless, it thus appeared that the familiar crude observation of coincidence on the same area between plague in the rat and plague in man which is logically incompetent to establish causality as between rat and man, was incompetent in fact also as soon as it was examined under circumstances in which knowledge of all the details could be got in a considerable number of instances.

14. The effect of these carefully established data might well have been to divert attention from the rat, but for the knowledge already acquired that the infection spread by means which were external to man. Thus the immediate direction which further inquiry must take was indicated. And it was noticed first of all that the infection might suddenly manifest itself on new areas which were separated by wide tracts of plague-free houses from any other area up to that time infected, and might there set going a sub-epidemic which should run its complete course independently of the course of the disease on other areas. This event, of which I have now recorded many instances, showed that the infection could be harmlessly transported over inhabited districts of wide extent, be planted afar, and there could take effect. In this phenomenon, it will be observed, there would be nothing unusual or noteworthy but for the fundamental observation that the infection is not epidemically diffused by the sick; and as it is not diffused by the sick themselves, so it seems to follow that it is not diffused by fomites either, for otherwise the evidence on the former point drawn from examination of the 266 and of the 124 plague-houses of the first and second outbreaks could not have been decisive, and might, perhaps, even have turned out to be unintelligible. It is also worth noting here that while, at Sydney, a very short line of wharves at which the produce trade (hay, grain, chaff, potatoes, bananas, &c.) is carried on, has always been the immediate source of the local infection, all the sub-epidemics referred to began either at produce stores or at stables to which produce had been carried from the neighbourhood of those wharves.

15. It was further noticed that the connection between the infection and locality was transient. Thus the outbreak of 1902 occurred on the area which had been invaded in 1900; but as the number of cases was less than half as large, parts of it which had suffered in 1900 were entirely spared in 1902. Still, reappearance on parts of the same area, though only on parts of it, permitted a suspicion that the infection might not have been completely removed from it in 1900, and this necessitated a closer examination. But first, what at bottom is meant by the convenient phrase "infected area"? As soon as this question is formulated it is seen from the data furnished by the grouped cases analysed above, that the infectiveness of areas depends solely on infectiveness of particular buildings standing within them. Perhaps the most striking feature of the epidemic diffusion (at least, after its independence of communication with the sick) was the erratic and even capricious way in which the disease manifested itself. It appeared in buildings which, though they stood in the same neighbourhood, were yet well separated from each other. There was absence of consecutive attack of adjoining buildings. It became clear, also, that the infection of man depended, not on his inhabiting a neighbourhood, but on his having visited particular buildings within it. Now, when incidence of the disease on buildings in the two outbreaks was compared in detail, the following data resulted:—In the first, circumstances caused 221 houses to be regarded as places of infection; 215 of them entirely escaped in the second. As for the remaining six houses, two of them were regarded as places of infection in the second outbreak only; in the first they had merely harboured persons who were thought to have received the infection elsewhere, so that four houses only were regarded as places of infection in both outbreaks. This seems to me a proportion so small as to be without significance, since re-invasion of the same area was almost certain to lead to re-invasion of some houses within it and it might have been expected *a priori*, of a much larger proportion than four. Then again it was found that the simplest operations of the scavenger cleared the infection away from houses as well as from districts once for all. Mere sweeping up and destruction of accumulated rubbish, the pulling down of a few ruinous outhouses, and a general cleansing of alley-ways and basements sufficed, without any disinfection properly so called. The more exact evidence on this head is drawn from examination of the isolated areas already referred to on which independent sub-epidemics had occurred; the uniform and (now) lengthy after-history sufficiently proves the point. They were liable to re-invasion of course, but it happens that plague has not reappeared on any of them. In short, the infection of plague does not inhere in places. Nor is there more than a remote analogy between the infectiveness of malarial places, and the infectiveness of plague-places, which latter is no sooner recognised than it may be summarily removed, and to which the disease in man is as nothing.

16. By these observations attention was forcibly redirected to the rat as cause, for they were at all events most completely explicable on the supposition that the infection was diffused by some animal which was free to wander among the dwellings of man, but which had access to the interior of only some of them. The kind of animal concerned was fixed, rather than indicated, by this hypothesis itself, because there is but one kind which lives in close association with man and at the same time is subject to plague. Many other kinds can be inoculated with this disease, and a few have been seen to contract it naturally; but the available evidence shows that they have always suffered secondarily, and that epizoötic plague has never begun among them. Hence it must be inferred, also, that plague is a disease which is proper to the rat. Another consideration seemed to be worth some attention although, doubtless, of a less cogent character; namely, while it is well known that the infection can survive outside the animal body for long under experimental conditions, it had practically never been identified outside it in nature notwithstanding the persevering efforts of many competent investigators. It remained, therefore, to endeavour by a special effort to establish some closer association between plague-rats and cases, or else to show that in reality such association existed but rarely and as an accident without signification for man.

17.

17. By following the direction thus pointed out, I found that the required close association between plague-rats and man did exist in every one of the small number of cases which constituted the outbreak of a later year (12). There were but twelve cases, spread over the seven months March to September; they occurred in nine buildings. In the smal central area, where the epizoötic had begun before the first case occurred, seven of the buildings stood, yet well, or even widely, separated from each other; the other two were situated at long distances from it, the one 6 miles towards the south, the other 10 miles towards the north. In the two last-mentioned neighbourhoods no plague nor any suspicion of infection had ever existed; and the only feature by which they were distinguished from the rest of the metropolitan district (save the central area) was the ascertained presence of plague-rats and of cases in the two buildings. So also the central area was distinguished from the rest of the metropolitan district (save the two distant neighbourhoods) solely by the presence of plague-rats and cases in man in the 7 buildings, and of plague-rats unaccompanied by cases at other parts of it. The link by which these three widely-separated neighbourhoods were thus connected was also definitely discovered. Materials which experience has shown to be especially dangerous in connection with the introduction of plague into clean places, namely, hay, chaff, and corn in the one case, and gunny-bags and similar wastes to be used in paper-making in the other, had been conveyed to the two houses from premises on the central area which were ascertained to be infected with plague in their rats. This instance should not be undervalued because the number of cases to which it relates is small. In epidemiological investigations accuracy and completeness are the essentials; large numbers introduce confusion and soon render the method impracticable. As it was, the time and labour entailed by quasi-detective inquiries into the circumstances of the patients at home, at work, and at leisure, into those of the businesses with which they were connected, into the state of the rats on premises occupied or frequented by them, into the state of the neighbourhood of the premises as to rat-infection and as to freedom from it, and the establishment of dates by documentary evidence whenever possible, from time to time unduly taxed the attention of a staff not exclusively devoted to the investigation of plague.

18. The next point to which I would draw attention is the fact that epizoötic plague is likely to be often overlooked. The most important of the obstacles to its easy recognition lies in its character; there are others which attach merely to the search-conditions. As regards its character, there is a prevalent idea that the disease is so easily and so rapidly communicated from rat to rat that large numbers must always suffer together, and that in its final stages it usually causes rats to leave the nests to which they have retired at its onset, in accordance with the habit of sick animals, so that they die in the open; and thus, between the two, it is thought the presence of the epizoötic cannot escape even the common observer. Both of these features have been noted, but often they are wanting, and oftener still they are indistinct. This appears not merely from my own experience, but from consideration of the evidence indirectly furnished by accounts of rat-plague in many other parts of the world in which the point is not discussed. I give my own precise evidence immediately below; but before proceeding to recount it, I venture an opinion that the very slow rate at which recognition of the rat as the essential cause of epidemic plague has improved is due, in part at least, to prevalence of this idea and to consequently inadequate searches. If, on the one hand, observed coincidences between plague in rat and in man on the same areas have accumulated in noteworthy proportions since 1894, and if during the last five or six years increased importance has gradually come to be assigned to the rat, on the other hand it must not be forgotten that occasional admissions of its active agency have been limited, that the infectivity of man and of the rat have lately been spoken of officially (13) almost as though they had equal importance, and that formal statements have from time to time to time been made that epidemic plague can occur in absence of rat-plague. The vague and unsatisfactory character of these latter seems to have escaped notice. I will not delay to examine them, and will only observe that sometimes they are unsupported by any evidence (14), sometimes they are supported by evidence which cannot but be regarded as inadequate (15) by all who have had practical experience of the difficulties with which demonstration of rat-plague is so often surrounded, and sometimes they have been supported by references to documents which are seen not to have the meaning ascribed to them (16, 17, 18,) as soon as the originals have been consulted.

19. As a rule, plague among rats in any district is so far from possessing a devastating character that its progress is slow, long-drawn out, and even insidious. The disease picks out individual rats, affects a minority of the horde at any one time, and exhibits its activity only in comparatively small, circumscribed areas which are successively attacked. On individual premises I have occasionally found almost the whole colony dead; but this has been exceptional, and even there the rule has been that few plague-rats and many more healthy rats have been collected during many consecutive weeks. I have already published several examples (19, 20) of this, which left little doubt of the fact; but the evidence was not perfectly good since it was impossible (save in one of those examples) strictly to exclude repeated invasions from the generally infected neighbourhood. Nevertheless, I can show from the cases of two ships that it was probably entitled to its *primâ facie* value; and the chronicity of epizoötic plague (not as disease, but as epizoötic) seems to me a circumstance of so much importance in relation to plans for the prevention of plague, that I shall describe them at some length.

20. The first example (21) is that of the troopship "Antillean," which sailed from Capetown on 1st February, 1901, after having lain repeatedly alongside in the docks at South Arm. She first touched at Albany, Western Australia, where plague has never existed, lay there in the stream for about forty-eight hours from 20th February, and sailed again for Sydney direct after having taken in a little coal. On 22nd February cleansing of the holds was begun preparatory to arrival and the reception of troops, and during these operations about fifteen carcases of rats were discovered and cast overboard; no definite statement as to their condition was got, but they were not dried up. She arrived at Sydney 2nd March, and reported one deck-hand sick; his case was clinically plague, the disease was identified by morphological, cultural, and inoculation tests, and he died on the fifth day of illness. The rats on board were destroyed by sulphur fumes and, as the vessel was in ballast, no difficulty was found in completely gathering their carcases; the total number was less than 100. The great majority were free from disease; more than two, but very few, were infected. In one of the two plague was identified by morphological, cultural, and inoculation tests, and was ascertained to be present in the other by morphological and cultural tests. At Capetown (22, 23), history of unusual mortality among the dock rats reaches back to middle of December, 1900, and the first identified plague-rat was collected there on 4th February, 1901. On 27th February, 1901, occurred the first case of the epidemic which, as is well-known, comprised 766 cases; but inquiry revealed (in all probability) two earlier cases, of which the first dated back to 24th January. It may be taken, therefore, that the infection present on board on 2nd March may have been active since a short time before 1st February, when the vessel sailed, but had certainly begun to take effect before 22nd February; yet a majority of the few rats carried were in good health, and this notwithstanding that the single store-room must have been a centre of attraction for all the rats.

21. The second case (24) is that of the barque "Alsterschwann," 2,500 tons, which left Buenos Aires 17th May, 1903, after having shipped a full cargo of maize in bags at Rosario, and which arrived at Sydney direct 29th July. When this vessel got alongside, many carcases were found beneath the hatches; but as the latter had been specially closed tightly with some idea of saving the cargo from deterioration, it was supposed by the master that these rats had been stifled.

Nevertheless, the occurrence came to notice, and it was learned that 112 carcases had been gathered and disposed of. The result of the search then carried out was collection of fifty-one rats and carcases of rats, all of which turned out to be healthy except two, in which plague was identified by morphological, cultural, and inoculation tests. Then, after a first fumigation with sulphurous-sulphuric fumes, a further and larger number of carcases were collected and examined, among which, however, plague was identified in nine only. This search was necessarily more or less superficial, for the cargo was still in the holds, but after a second fumigation the barque was taken alongside, and unloading allowed to begin; a great many more comparatively fresh carcases were afterwards turned out, but the fact of plague infection having been fully established already, further examinations were not made. Plague first appeared at Rosario (25) in September, 1899. The infection must have been carried aboard the barque during seventy-four days, notwithstanding which a large majority of the rats which were examined were still free from plague.

22. General experience ashore, as distinguished from that derived from particular premises, was to the same effect. Thus the length of the epizoötic periods in each of the four years 1903–1906, reckoned from the first day to the last day on which a plague rodent was identified, was 14, 40, 47, and 49 weeks respectively. The total number of rodents examined during each of these terms was 14,671, 43,822, 28,446, and 27,731. Although there were exceptions, they may be regarded as having been all taken on the same small area of the city, and they were collected by the rat-intelligence staff in a regular way, the numbers brought in week by week having been approximately uniform. All of them were examined in the laboratories, and plague was identified in 161, 243, 141, and 174 of them. Some of these identifications were recorded almost in each week of each of the four terms; although there were some longer intervals, they occurred quite irregularly. The small proportion of plague-rats attracts attention, and is due in part to the account having been restricted to those carcases in which the disease could be bacteriologically recognised. Other carcases were submitted which were too far advanced in putrefaction for that kind of examination, some of which may be presumed to have resulted from plague; but their number was not large, and if reckoned, would not materially disturb the proportions mentioned, and would not at all disturb the time relations.

23. This evidence shows, I think, that epizoötic plague may pursue a chronic course, and that its long continuance may not be attended at any stage by such a mortality as could not be easily overlooked. Indeed, the figures just quoted show that there is difficulty in proving that any of the epizoötics referred to did much damage to the rat-tribe as a whole. But this difficulty owns two causes at least. As the putrefying bodies of plague-rats are not a cause of nuisance much more often than are those of the rats which die from day to day in the natural course, I suppose most of them die in the nests to which they have retired on first falling ill. The other cause is the conditions which prevent dwellings and warehouses from being thoroughly searched, unless the sanitary staff has taken possession of them; privacy and the course of business cannot be so hampered without substantial reason. However, when whole blocks of houses have been taken in hand and systematically cleansed, no remarkable number of rats ever has been turned out. When that course has not been taken, then the difficulties in the way of securing plague-rats, save in small number, have lain in the fact that only healthy rats, active in their search for food, are likely to be, and as a rule are, trapped; yet trapping is the only means available to an intelligence staff, for systematic poisoning no more leads to discovery of carcases than does plague itself.

24. Under all these circumstances, it will be perceived, rat-plague might easily be overlooked in places where the search cannot be, or is not, systematically and thoroughly carried out, and I have no doubt that it has occasionally escaped detection in this or that isolated area at Sydney, where the contrary was the case. It will also be judged, probably, that elaborate rat diagrams are not worth the labour of planning, for the figures on which they are based are necessarily incomplete, and largely result from incalculable chances by which even their relative value is vitiated. The fact is that the whole truth concerning epizoötic plague cannot be learned, and he who should accept the greater or less number of carcases observed in circumscribed districts as indicating greater or less need for energetic measures would often be deceived. The best search can at most only enable the limits of the area over which the epizoötic has extended to be defined, but that it can do with considerable accuracy. From all this a very important practical rule derives, namely: Discovery of a single infected carcase should be taken as peremptorily indicating the most thorough scavenging and cleansing of the neighbourhood in which it was found. Rarely will the labour entailed have been spent in vain. The case is quite different with an imported case in man; that, as we have already seen, calls for no action in respect of the neighbourhood.

25. Here a note on the species of *Mus* met with at Sydney, on their susceptibility to plague under natural conditions, and on the observed association of the different species with plague in man, may be usefully inserted. The species are *M. decumanus*, *M. rattus*, together with its Alexandrine variety which it is unnecessary further to mention separately, and *M. musculus*. These comprise all which have become domesticated. Plague has been identified in all of them, and in such numbers as shows, I think, that the proportions of each species enumerated in any year depended rather on local distribution than on any difference in susceptibility. In the first year to which I now refer, plague was identified in 86 D., 26 R., and 49 M.; in the second, 106 D., 73 R., and 62 M.; in the third (26), in 78 D., 45 R., and 18 M.; in the fourth (27), in 46 D., 89 R., and 39 M. I have found each of the two species of rats infected and associated with plague in man by itself, as well as the two together on the same premises. Infected mice have never been found alone in that association, so that I have nothing which points to the mouse as an efficient cause of plague in man; on the other hand, I have not observations sufficiently extensive to show that it does not so act. In a short series of nine houses, infected *M. musculus* was once actually found alone in association with one case of plague, but rats had at the same time died in number on the premises, although none were secured in a state which admitted of identification of the infection; *M. decumanus* was associated alone in a second, *M. musculus* and *M. decumanus* together in a third, all three species together in a fourth and fifth, and *M. musculus* with *rattus* in the remaining four. All the rats on the troopship "Antillean" (see above), on which was one case of plague at arrival, while another (to which it was unnecessary to refer before) occurred in connection with cleansing of the store-room, were *decumanus*. All those found on the other vessel, the "Alsterschwann," were *rattus* in its Alexandrine variety; in that instance no one was infected, either among the crew or among the many persons engaged in unloading and in disinfecting her. In a rural district, 300 miles from Sydney, where twelve cases occurred in ten houses, all the rats (1,128) taken, whether in the houses or in farm-buildings or on river banks, were *decumanus* with three exceptions; all the infected rats (101) were of that species, and there were two infected mice. At an important seaport 70 miles to the north of Sydney, where an outbreak consisting in fourteen cases occurred, plague was identified in 206 rodents out of 6,653 examined; 171 were *decumanus*, 13 were *rattus*, and there were 22 mice. The association of the infected species with plague in man at this place in the eleven cases which could be so examined was *decumanus* alone eight times, *decumanus* and *musculus* together twice, and *decumanus*, *rattus*, and *musculus* together once. The species found in connection with two large warehouses at Sydney where eight cases occurred was *rattus*; all the patients recovered. That connected with six cases which occurred at a small hotel was also *rattus*, and two of these patients died. The records might be further examined with quite similar results, but perhaps enough has now been said. After having

mentioned the caution that the following opinion does not result from complete knowledge, but only from what happened to be discovered, I may point out that the experience appears to indicate *M. decumanus* as rather the more susceptible, and practically rather the more dangerous. At all events, the suggestion recently made that in this relation *M. rattus* is the species to be feared, and that *M. decumanus* is, or perhaps may be, harmless, would fatally influence preventive operations at Sydney if it were adopted, and if it were possible to so conduct the destruction of rats as to spare the *decumanus* species on the ground that it would eventually destroy *rattus*. Doubtless there are variations in the susceptibility of the two species, and of each species in different countries or even in different parts of the same country ; but I incline to think that the proportions observed to be infected depend primarily on local distribution.

26. If the evidence in general which has been adduced be now reviewed, I think it will be admitted that it goes very far towards proving that epidemic dissemination of the infection is effected by the rat alone. But it does not in any way explain communication of the infection from the rat to man. The evidence that the dead plague-rat is commonly harmless to man, though opposed by it, is not rebutted. The observation that association with plague-rats is most often without consequences to man remains unshaken, as also does the more important observation which teaches that when association has been accompanied by infection of man, much the most often only one person has been infected out of the whole of the exposed party. This led me from the first to suppose that solution of the epidemiological problem lay entirely with the manner in which the infection is communicated to man (28).

27. Practically the ways in which man may take the infection, that is to say, the ways which may so frequently come into operation as to cause epidemic prevalences, are but two ; namely, inoculation and feeding. The pathological evidence thus far relied upon to establish infection through the digestive tract in reality merely shows that the disease often involves that part of the body. It does not show that it has entered the body by that route. Quite recently, however, the variable success attendant on feeding experiments with animals has been made the subject of a special investigation (29) conducted on the assumption that the virus is liable to be destroyed by contact with the acid contents of the stomach (as in cholera), and that greater certainty might be attained were it protected during its passage through that organ so as to be released in the ileum, where it would be exposed only to alkaline liquids. This hypothesis, it is said, has been justified by the results of feeding animals with small infected masses so dried externally as to resist peptic digestion. On the value of these results I am incompetent to offer any opinion. But I may draw attention to the practical considerations which prevent me from seeing how this mode of infection could operate in man, save exceptionally. The requirement is that the virus shall be discharged by rats (or by man) in small masses of the secretions of the body such that they may dry externally so as to form a protective envelope to the virus in the interior parts ; and in these experiments the drying took from twenty-four to forty-eight hours, even over sulphuric acid. Discharge in the required form no doubt can happen. But the essential drying, I think, could not be brought about under natural conditions so as to produce infection of man, because his food either is moist itself so that the drying would be prolonged, and putrescible so that it must be speedily eaten ; or it is moist though not putrescible and cannot be eaten (or at all events is not eaten) after the drying which a few hours brings about (bread) ; or it is dry, but too uncommon an article of diet to enter into a general cause (biscuits) ; or, lastly, it is dry, but incapable of being eaten until cooked (potatoes, grain). As between rat and rat the last-mentioned objection does not hold, and if the experiments referred to should be successfully repeated by others, it would then appear that rat-infection may occur in this way ; however I am not now considering that point, but the mode of communication between rat and man. Certainly the infection of man is not commonly brought about by feeding, and it seems to me that this conclusion rests securely on the general pathology of the disease.

28. The same pathological evidence strongly supports the more generally received opinion that the infection is taken by man by inoculation. Indirect evidence is furnished by the observation that the frequency with which buboes appear in this or that region of the body is closely proportionate to extent of the drainage-area from which the lymph which is filtered in the glands of those regions has been drawn (30). The bubo is the characteristic lesion of plague, and is seen in all those cases in which resistance to the infection has been sufficiently strong. Its absence merely shows that resistance was defective, either absolutely or in relation to the dose or to the strain of the inoculated virus ; and when the bubo does not form, then primary septicæmic or primary pneumonic plague results. The bubo appears where the assault on the body was first delivered and was most strenuously resisted, and it is distinguishable from the general glandular enlargements which later occur in every part of the body by the vastly greater damage done to the gland. All the lymphatic glands ultimately exhibit some rosy tumefaction ; but one, or rather often two or three adjacent and immediately connected glands, alone show evidence of the violent struggle just mentioned in hæmorrhage, necrosis, and periadenitic effusions, and they alone indicate the area of skin into which the virus was inoculated.

29. Inoculation into the skin might be effected in two ways. The virus may be deposited by rat or by man on inanimate objects with which the skin of healthy man may come into contact. Such conjunction is not sufficient to infect, as is seen from the impunity with which *post-mortem* examinations are habitually made, unless the skin happens to be wounded. The uninjured skin is an efficient defence against infection by casual contact with the virus. These considerations have long been entertained, and originally it was thought that the preponderance of groin buboes among unshod people resulted from absorption of the infection through the wounds commonly present on undefended feet. But at a very early stage comparison between shod whites and unshod natives exposed on the same area showed that groin buboes preponderated among the former just as they did among the latter. So in 1900, I observed that out of 286 habitually shod persons who exhibited buboes no less than 73 per cent. had them in the groin (31). Casual inoculation through pre-existing wounds of the skin of the lower extremity is not the reason, then, why buboes are most commonly found in the groin. Nevertheless, probably infection could take place by that means ; but difficulty in accepting this as the common explanation arises, as usual, in direct observation. Wounds of a competent character are rarely exhibited, and when the patient can account for them I have often found either that they were received after the probable date of infection, or so long before it that the trivial abrasion must have healed at a date prior to that of infection sufficiently to prevent entrance of the virus by it. Recognition of this mode of infection as the common mode rests entirely on theoretical grounds. Minor abrasions heal sufficiently to repair defences in twenty-four hours ; and on reflection it will be perceived that rats can deposit the virus only on few and scattered spots, and that the chances against apposition between them and that small part of the body which carries some slight abrasion before lapse of the brief time within which the latter becomes repaired, must be incalculably great.

30. In 1902 I proceeded to inquire into the way in which man came to be inoculated in the course of daily life by the same method as had yielded the results already described in connection with other points, and to seek in the field some explanation of the fact that such inoculation takes place in the lower extremity more frequently than elsewhere (32, 33). First, I found that 106 out of the 139 cases of that year exhibited buboes in the groin. But as buboes in the femoral chain alone are evidence of inoculation in some part of the lower extremity, forty-six cases in which they were

situated in the inguinal chain had to be thrown out; sixty remained. But the majority of these sixty were for various reasons not available for my purpose. Thus, in sixteen of them either the place at which they were infected could not be determined, or the evidence for infection at home and at work was equally cogent, while in twenty-five others it was considered that the infection had been received at home, where, consequently, the patients had been exposed at bedtime to the risk (if any) attaching to bare feet which it was necessary to exclude. In four others the general history of the patients was defective; and in still three others, although infection probably did take place at work, the evidence was considered to be not quite unimpeachable. The result of this rigid sifting was rejection of forty-eight of the sixty cases, so that ultimately twelve remained in which *solitary* buboes situated in the *femoral* chain were exhibited by persons whose movements had been ascertained with certainty, and who beyond reasonable doubt were infected while at work. At their work-places they were all fully clothed. But their skins were not completely protected by their clothes. Their hands and arms, their faces, necks, and (as the weather was hot) often their chests too, were exposed; only their lower extremities were invariably protected by boots, socks, and trousers or petticoats. Yet they were inoculated not in their exposed parts, but in their protected parts. The deduction was almost obvious, and quite unavoidable. Inoculation must have been effected by some agent to which neither clothes nor the epithelium offered insurmountable obstacles; by some agent which could evade the one, and which could penetrate the other without causing either noticable pain or a visible wound. The flea alone answered these requirements. Moreover, within buildings fleas live in the dust between flooring-boards and in corners, outside them in the soil, and notoriously reach the legs first in places where they abound.

31. When these observations were first published (1903) there was very little experimental evidence that the flea possessed even the power of communicating plague between animals. It was limited to Simond's successful attempts in two experiments out of four made with an undetermined species of flea (1898), and the five successful experiments reported five years later by Raybaud et Gauthier (34, 35), which were made with the species *Ceratophyllus fasciatus*. Against these rare successes were to be set the greatly larger number of failures reported by several competent observers, and from my own laboratory. Since then, possession of this power by the species *Pulex cheopis* (Rothschild) has been placed beyond dispute by the First Report of the Plague Research Committee which was appointed as the outcome of representations made by the Lister Institute to the Secretary of State for India in 1905, and which is still working in India under direction of Dr. Charles J. Martin, F.R.S., Director of the Lister Institute (36). It may be expected that in its next report the Committee will be able to define the conditions under which this power is exercised, both in relation to species of fleas and to mechanism. Probably all fleas share it on condition that they are of kinds which infest rats and sometimes attack man. This is the more likely that the position of the bacillus among the schizomycetes seems to connote a merely mechanical transference of the infection by the flea (37); but on the other hand my field-observations seem to me to require duration of the power to infect over considerable, and even over rather long periods (38). In conclusion on this head I would point out that although the experimental demonstration thus furnished is essential, and may be accepted as affording ground for inferring that the virus can also be conveyed by the same means from lower animals to man, yet the importance of this mode of infection as a factor in production of epidemic plague can be established only by observation in the field of daily life. I conclude from the investigations which have just been described above that while plague may be casually acquired by man in several ways, the flea is the ordinary agent of his infection, and it as well as the rat is indispensable to produce epidemicity.

32. Thus the lines which must be followed in efforts to prevent or to check plague are very clearly indicated. It is not possible to discuss this subject in detail within the limits assigned on the present occasion, but a few leading points can be mentioned.

33. In the first place, notwithstanding that plague is not *maintained* by communication of the infection from the sick, yet it is communicable from them and occasionally is seen to be so communicated. Further, although such communication from them as occasionally takes place cannot by itself give rise to epidemics, the following consideration is entitled to weight, namely: Since plague can be and generally is communicated from rat to man by the flea, so it must be possible for it to be communicated from man to the rat, an accident which might bring about an epidemic But the frequency with which this risk will be encountered depends first on parasitic infestation of the patient; secondly, on his proximity to rats; and thirdly, on his disease having reached the septicæmic stage. These are chances which must weigh importantly in all countries against communication of the infection from man to rat, although in some they may have less influence than in others. Plague in the rat is almost always a septicæmic disease, but in man the primary septicæmic form occurs much less often than the bubonic; yet any bubonic case may become septicæmic shortly before death, and many do so. My own experience has furnished little which pointed to transference of the infection from the sick even to man when the circumstances have been fully discovered. In some cases which at first seemed doubtful, inquiry ultimately established presence of plague-rats, or in a few in which nothing explanatory of the infection could be found, the evidence as a whole was so defective that they had to be set aside as merely undetermined; but in three or four probably the infection was so communicated. In some countries, as, for instance, India, a contrary experience may perhaps be common, and in course of time may be shown to be so on tangible evidence; still, India, is a country where association between people and rats seems to be much closer and more nearly universal than elsewhere. However that may be, I would express the opinion that every case of plague should be segregated, and I note that every case has always been and still is segregated at Sydney within a few hours of notification. Never have I had reason even to suspect that the infection had been communicated from man to rat.

34. Secondly, it would seem that preventive measures should be directed, not only against the rat, but against the flea, and this course has been advocated. I think it evident that it cannot be taken with hope of practical success, save in special circumstances. They are these: When plague-rats have been found in a dwelling or other building which is about to be cleansed, the first thing to be done is to spray the floors very freely with a 5 p.c. solution of coarse carbolic acid, or an equivalent solution containing mixtures of the tar acids. This is a very effectual method of driving away and of killing fleas, and thus of avoiding the only risk connected with the cleansing of plague-infected premises. The residuum left from the distillation of kerosene is also efficacious for this purpose; but it is a stinking and oily substance, of which the use is limited by those qualities. For the rest, it seems to me that effort to destroy fleas, which cannot be successful, must divert attention from the rat, or at least divide it. Now the flea derives its importance from the rat; and although it wanders to some distance after its host has died, still the direct attack should be upon the rat. The rat is the *fons et origo* of the infection for man.

35. Rat destruction is a subject on which a great deal might be said. Extermination of the rat is impossible with any means thus far made available. Perhaps larger numbers have been destroyed during several years at Tokyo (39) than anywhere else, and yet it was hardly possible to recognise any impression made on the rat-tribe as a whole. My own experience has been similar; but from time to time diminution in the numbers present in circumscribed districts has been

produced by energetic poisoning and trapping. This has importance in relation to the limited areas over which the epizoötic extends at any one time. But although occasions will arise from time to time on which effort may be directed to destruction of rats known to be present, as a rule infected neighbourhoods must be dealt with in a more general way, by scavenging and destruction of accumulations or places in which rats have found, or probably may find, harbourage, and especially by storing food and food-wastes so that rats cannot reach them. These operations should be guided not by rats seen, or even traced, but by the conviction otherwise acquired, that rats must be present, seen or not seen, wherever man has been infected, and can be driven out. Unless rat-staffs are firmly impressed with that belief, such operations will seldom be thoroughly successful.

36. Lastly, the difficulty in arresting rat-plague is, in my local experience, in direct ratio to the bad construction of wharves, quays, and the buildings upon and near them. The danger to man from plague is everywhere directly proportionate to the accessibility of the interior of buildings to rats, although it is not quite absent outside them. When the difficulty of staying the infection by action directed to the rat is considered, and, above all, the impossibility of staying it within so short a period of time as shall effectually avoid the danger to man, I think it will be perceived that the rational method of defence lies in so improving the construction of buildings as greatly to impede the entrance of rats to them, and in so taking care of food that it shall not attract them.

37. In a broad view, then, all other measures must be considered as subsidiary to re-construction of ill-built wharves, stores, and warehouses, and to such repair and special fitting of inhabited houses as will keep rats outside them. It is easy to convince the intelligent laity that this advice is based on sound reasons; but unfortunately it is very difficult to satisfy them that the considerable expenditure it connotes will yield an appreciable profit to the community, and an efficient protection to individuals against losses which sometimes are almost ruinous.

Sydney, 28th April, 1907. J. ASHBURTON THOMPSON.

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[Four Diagrams.]

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